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CULTIVATION OF BANGOS IN THE PHILIPPINES

By WALLACE ADAMS, HERACLIO R. MONTALBAN, and CLARO MARTIN
Of the Division of Fisheries, Bureau of Science, Manila

TEN PLATES AND NINE TEXT FIGURES

INTRODUCTION

The remarkable adaptability of the bañgos and its acceptable qualities for the ember and pot early attracted attention in many lands. In no other fish of the same habitat are desirable characters so favorably combined as in the bañgos. Rapid of growth, vegetarian, and absolutely noncannibalistic in habit, prolific by nature, and palatable in flesh, the bañgos as a pond and food fish is without question one of the best. The availability of the fry or the tiny young in numerous quantities during certain seasons of the year is a very important factor in its favor. The bañgos is one of the few known marine species that are adaptable to artificial cultivation in salt- and brackish-water ponds.

The date of the inception of fishponds in the Indo-Pacific region is still a matter of conjecture, but the development of bañgos culture has been very slow as can be seen even in the best practice to-day, which still retains some of the original features. The present method of bañgos cultivation is the outcome of evolution through the lapse of many centuries.

The first fishponds for marine fishes were of simple construction. Small bays or inlets indenting the shores were walled at the narrowest entrance and the inclosed space was used as a pond. In the wall was an opening provided with a gate by means of which the water could interchange and the fish carried by the

incoming tide could freely enter but were prevented from returning to the open sea. Obviously, through this method, it was exceedingly difficult to control the stocking of ponds and the outcome was always uncertain.

It is claimed that fishponds of this type have reached the greatest development in the Hawaiian Islands, where they have been in use in the cultivation of mullet and bañgos for centuries. However, nothing definite is known as to the origin of these ponds, although a number of them already past the two-century mark are still in practical use. The method of construction of most of them is to build a wall of lava rock across the narrowest part of the entrance to a bay and provide a convenient opening with a gate.

The basic idea of the Hawaiian method was made use of extensively in the fishpond construction in Java, Madura, Formosa, the Philippines, and in many other localities where the development of this fishery was undertaken and the introduction of various changes became evident. In the East Indies, tide lands and mangrove and nipa swamps were found appropriate for the building of fishponds. With the conversion of these vast areas into favorable cultural sites, it became necessary to dispense with the old, inadequate, and uncertain method of stocking the ponds, and a new and more efficient way was adopted. This consisted of collecting and transferring the desired fry into especially designed ponds.

In the Philippines bañgos culture probably started on the shores of Manila Bay around the City of Manila. There have also been fishponds around Iloilo and on Mactan Island for a considerable period.

In spite of the long time that the bañgos-pond industry has been in existence, primitive practices are still in vogue in many fishponds in the Visayas. The chance entrance of bañgos and other fishes is depended upon to stock the ponds, and generally there is but one compartment to a fishpond system. Under this crude method it is, therefore, not surprising that the Visayan fishponds contain a more heterogeneous assembly of fishes than those around Manila Bay.

Until recent years there has been little improvement in the methods employed. The bañgos fishpond industry has reached its greatest development around Manila Bay, where according to estimated figures it now represents an investment of over 45,000,000 pesos. The most successful practice is in the region about Malabon, a town a short distance north of Manila. The

largest ponds are found in Pampanga, Bulacan, and Bataan. The industry has likewise been developed in Iloilo and Capiz Provinces, and in Negros. It has been established in a minor way in La Union, Pangasinan, Zambales, Cebu, Antique, Leyte, and other provinces.

The present paper is offered as a help to those already engaged in the industry and to those about to engage in fishpond culture. It sets forth ideas worked out in actual practice and those known to be an improvement over the old methods, perhaps necessary in their time but now obsolete. Portions of a similar paper [1] have been used, but for the most part the subject matter is entirely new and based largely on more recent information.

NAMES GIVEN TO THE BAÑGOS

The English name for bañgos is "milkfish;" in the Philippines it is called by the following names: Ilocano, *awa, bañgos;* Pangasinan, *awa, betel;* Tagalog, *bañgos, bangris, laon, lumulukso;* Pampango, *bañgos;* Bicol, *bañgos;* Visayan, *awa, bañglus, bañgros, cugao;* Samal and Tao Sug, *bañgilis.* The very young, or fry, are called *bugui* in Ilocano, *kawag-kawag* and *kakawag* in Tagalog, and *awa-awa* in Visayan; in Tagalog, the fingerlings from 5 to 10 centimeters long are designated as *hatirin,* those from 10 to 12.5 centimeters in length as *garongin,* and the full-grown bañgos as *sabalo* and *lumulukso,* the latter term being given to those exhibiting a remarkable leaping ability.

CLASSIFICATION AND DESCRIPTION

The bañgos is known scientifically as *Chanos chanos* (Forskål), the sole living representative of the family Chanidæ. It is a brilliant, shiny silvery-white fish, with a pale steel-bluish back. The body is fairly elongate, moderately compressed, and covered with small, smooth scales. It has a pointed head, an arched back with a single dorsal fin, and a large tail, deeply forked. The mouth is small, terminal, oblique, and toothless. A thick gelatinous substance, very thick at the eye region, covers the snout up to the nape and the eye and its neighborhood.

FOOD

The bañgos is vegetarian and subsists mainly upon diatoms and other plankton organisms, the leaves of submerged plants, and algæ. The fry feed upon microscopic plants and animals, and upon the surface scum found along the muddy bottoms of

[1] Philip. Journ. Sci. 38 (April, 1929) 451–509.

quiet shallow bays and tidal creeks. When the natural food supply is abundant the bañgos grows very rapidly.

DISTRIBUTION

Bañgos is a fish of the open sea and occurs throughout the Philippines, often entering the fresh-water rivers and such lakes as Taal, Naujan, and Bato. It is found on all the coasts in the Indian Ocean as far south as Zanzibar, also on the coasts of Asia and Formosa, and is seen occasionally along the coasts of southern Japan. In the Pacific, the bañgos may be found about Hawaii, Samoa, and East Indies, and the Society Islands and even as far as Australia and New Zealand. It is abundant in the Gulf of California and along the coast of Mexico.

BREEDING HABITS

In the Philippines as far as can be ascertained, the bañgos spawns from March to June or July. It seems to spawn off quiet shallow sandy coasts, where the fry are found along the shore in immense numbers. The bañgos is among the most prolific of fishes. A ripe female, about 75 centimeters in length taken in Subic Bay April 10, 1927, contained a little over 3,000,000 eggs. In Batavia, Java, a bañgos 1,120 millimeters long had roe about 940 millimeters in length, containing 5,700,000 eggs.

When adult, bañgos reach a length of a meter or a meter and a half.

It is a well-established fact that bañgos do not reach sexual maturity in the fishponds no matter how large the ponds may be nor how long the fish are kept in captivity. Even in lakes, such as Taal, Naujan, and Mainit, where they grow to a large size, they have never been observed to breed. The reason for this is that in these more- or less-confined surroundings the conditions are never as favorable for reproductive purposes as in the open sea.

IMPORTANCE OF BAÑGOS AS A FOOD FISH

Of more than sixteen hundred species of fishes recorded from the Philippines, bañgos is the most important. It is by far the leading fish in Manila markets, and is the product of an industry in which a vast amount of capital has been invested. Young bañgos, only a few months old, is the bañgos ordinarily found in the markets. The adult is seldom caught and is consequently rarely seen.

Bañgos has a fairly high nutritive value. The edible portion, which is 70.56 per cent of the whole bulk of the fish, is made up

of 19.24 per cent protein, 5.57 per cent fats, 0.10 per cent carbohydrates, and 131.1 calories per 100 grams.

SUGGESTIONS TO PROSPECTIVE FISHPOND OWNERS

An ideal fishpond system should be divided into a number of compartments or made up of several connecting ponds that are operated as a unit. These subdivisions naturally vary in size and depth, since they must accommodate fish of different sizes and are used for different purposes. In the region of Malabon a system of ponds for rearing bañgos from the fingerling stage to marketable size consists of the catching pond (*kuluñgan*), nursery pond (*impitan* or *bansutan*), and rearing pond (*kaluañgan*). The young bañgos with which this system is stocked are taken from such localities as Dampalit and Navotas, where they are raised in the nursery (*pabiayan*) from the fry stage to fingerling size; that is, to approximately the size of a man's finger. The other system of ponds, which is dependent upon bañgos fry for stock, is similar to the above with the exception that the nursery contains both the pabiayan and the impitan or bansutan. Each system must necessarily have a head gate for the admission and exit of water. It is located on the side of the kuluñgan adjoining the estuary (*estero*). In addition to the head gate, it is also advisable in a good fishpond system to have a secondary gate. This is usually placed between the kuluñgan and kaluañgan. A third gate, of smaller dimensions, should be provided to connect the nursery ponds with the kuluñgan.

Before engaging in the fishpond business in a locality where the industry is not yet established one should be absolutely certain that the young bañgos can be obtained nearby, or that they can be readily brought from regions where they are abundant. Those contemplating engaging in bañgos culture should spend sufficient time in the region around Malabon and Pampanga to acquaint themselves with the methods of fishpond construction and of rearing bañgos employed by the more successful bañgos growers. Such things as the construction of dikes and gates, the proper method of handling the flow of water, the care of the fry, and the growing of food for the bañgos are better learned from observation than from printed matter.

SELECTION OF FISHPOND SITE

Large areas of swamp lands or tidal flats suitable for fishponds occur along the coasts in many localities in the Philippines. In general, six factors are of prime importance in choosing a site;

namely, the soil, the vegetation, proximity of a good tidal stream, drainage, freedom from floods, and nearness to the market.

The soil.—Clay is the most desirable soil. It is not only retentive of water but is also best for the growth of the vegetation upon which the bañgos feeds. Sandy soil is, of course, not practicable, and soft mud is unfavorable to a good growth of algæ and injurious to the fish. Neither of the two is suitable for dikes.

The vegetation.—Mangrove and nipa swamps are ideal for fishpond sites. Most of the nipa palms, mangroves, and other plants are removed before using the land for a fishpond, and only a few should be left for shade.

The proximity of a tidal stream.—Great care should be taken to see that the fishpond is sufficiently near a tidal stream to insure a plentiful supply of salt or brackish water throughout the year, especially during the dry season. Fishponds may be located in the interior where the soil is loamy; the only objection against such a location is that during the greater part of the year the water is fresh, making it possible for the voracious dalag to live in the fishponds. In general the most suitable sites are marshes and deltas.

Drainage.—There should be complete drainage in fishponds, and the inflow and outflow of water must be brought under control, so that the bottom can be dried out to get rid of the enemies of the bañgos and to permit an abundant growth of algæ.

Freedom from floods.—Land with fresh-water streams crossing it and land that is subject to flooding by fresh water during the rainy season should be avoided.

Nearness to the market.—It would be useless to have a bañgos pond without a market close by or else adequate cheap transportation to a good market.

CONSTRUCTION OF FISHPONDS

The cost of constructing a fishpond varies with the soil to be worked, whether clayey, muddy, or rocky; with the topography, whether level, sloping, or undulating; with the vegetation present, whether nipa, mangrove, etc.; and also with the labor conditions of the locality.

Dikes.—After the site has been selected, the next step is to plan the layout of the fishpond system. Once the location of the main dike about the pond has been marked off, the cutting of mangroves or nipa palms is started. Sometimes at the beginning only the portion of the main dike and the adjoining strip

of land from which the soil is taken for the dike are cleared. In the construction of the main dike, the soil is removed from the middle along its entire course to a depth of 30 to 60 centimeters and to an equal width, forming a V-shaped trough called a puddle trench (*mecha*). The soil removed is placed on the outside bank of the trough. The soil for filling the trough and main dike is taken from the inside of the pond, leaving a berm about as wide as the base of the dike. A marginal canal or borrow pit is thus formed. This is deeper than the rest of the pond (fig. 1).

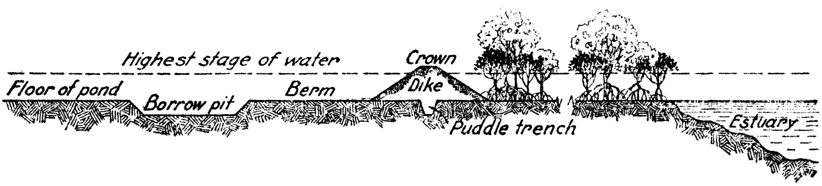


FIG. 1. Cross section of main dike showing puddle trench, berm, borrow pit, and floor of pond.

The dike is not raised at once to its required height, but this is attained by piling up mud layer by layer and allowing each layer to shrink before another is laid on. The dike should be about 30 centimeters higher than the level of the highest tide during the year. The crown of the dike should be at least 50 centimeters in width, and the slope 1.5 meters horizontally to 1 meter vertically. The puddle trench referred to above serves to make the dike more resistant to water pressure, prevents seepage of water, and closes holes bored by crabs, sea mantes, and sea scorpions. All stumps, logs, and sticks of wood should be removed, for if left they will rot and ultimately let water escape. Dikes should be made strong enough to render them capable of withstanding inundations and freshets. Sometimes rows of mangrove (*bakawan*), *Sonneratia* (*palapat*), and nipa palms are planted in front of the dikes, especially if they are along the river bank. The purpose is to hold the soil and break the violence of the water current, wave action, and wind.

Gates.—Gateways are, of course, necessary in the dike to control the inflow and outflow of water (figs. 2 and 3). There should be one head gate to every 10 to 15 hectares of fishpond. It is placed in that portion of the pond where the entrance and outflow of water would be most effective, usually near the mouth of a creek or at the deepest portion of the pond to allow complete drainage.

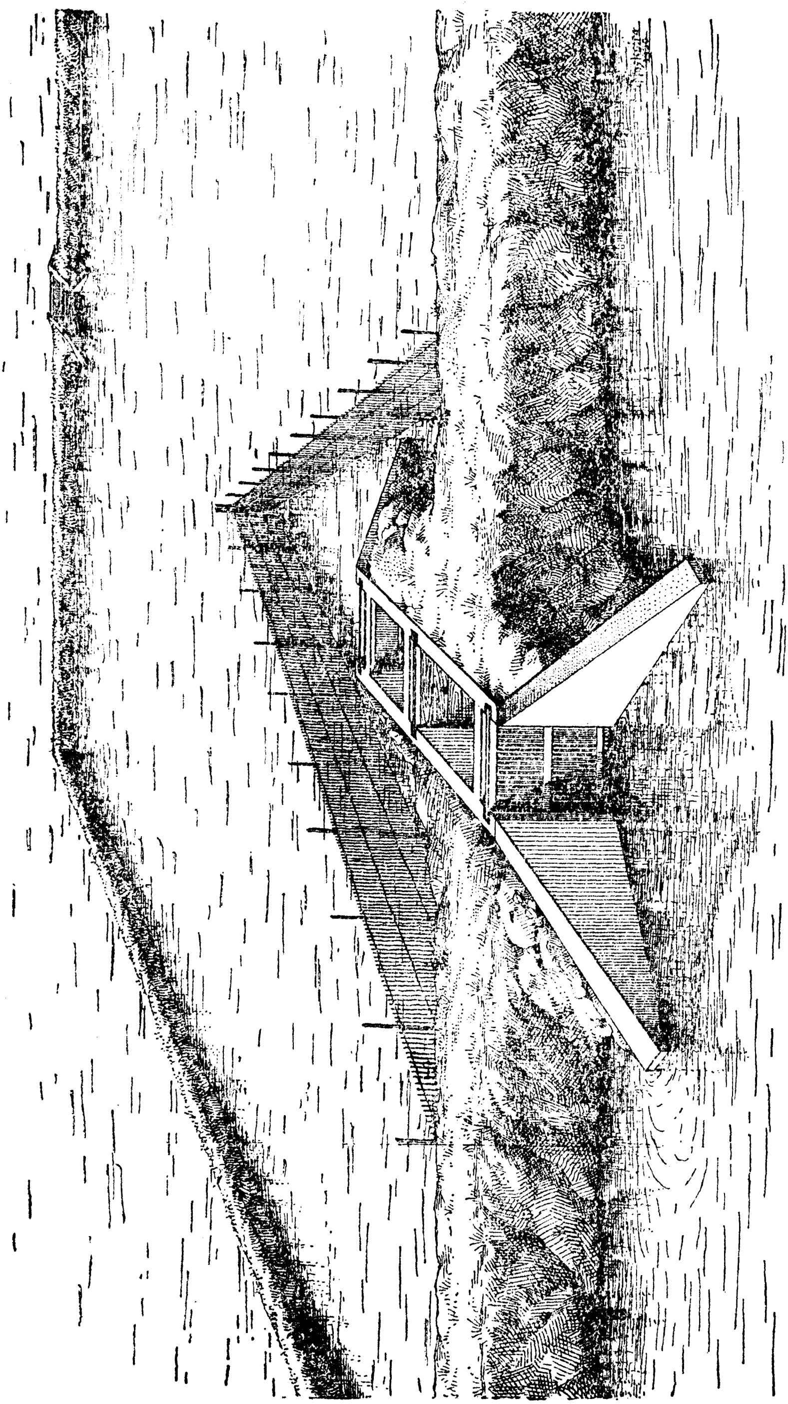


FIG. 2. Schematic sketch showing kulungan, head gate, saplad, and secondary gate in background.

The main gate should be constructed of concrete. Formerly this was made of stone and cement, brick, or even of wood, but the superior merit of concrete for construction is gradually forcing out all other materials. The main gate should be of ample dimensions, with a large base set on a very strong ground foundation. If the ground is soft and lacks uniformity it is necessary to drive bamboo or hardwood pilings. The width for the passage of water in the gate should be about 1 meter (fig. 3).

A rectangular space is dug in the ground where the gate is to be constructed. If the site selected is submerged most of the time an inclosure of mud is first made before digging is started. The space is kept as free as possible from excessive water while excavation and work on the floor and basal portion of the gate are in progress by bailing the water out. After the required depth is reached bamboo or hardwood piles a meter or more in length are driven into the bottom. The heads of the piles are covered with concrete mixture about 20 centimeters in thickness, in which $\frac{3}{8}$-inch reënforcing bars are placed for additional strength. This concrete layer or base forms the floor of the gate and should be lower than the bed of the pond. The side walls and wings of approximately the same thickness as the floor, properly reënforced, are erected over the concrete base. They should be as high as the dike. The wings should extend out diagonally to the extreme base of the dike from the ends of the side walls, to prevent the water cutting in at the sides. As protection against the undercutting effect of the water, the gate should be provided with an apron at each end, which should extend as far as the wing walls. The apron should slope down considerably so that its extreme lip will be at the lowest level of the water at the point of entrance. For all concrete mixtures for the construction of gates, the proportion should be 1 part of cement, 1.5 parts of sand, and 3 parts of gravel.

Three pairs of vertical grooves are left in the side walls. The middle pair is fitted with guide boards along which the slabs or boards of durable wood, placed edge to edge, slide up and down. These slabs may be removed or inserted to regulate the flow of water or stop it altogether. The two other pairs of grooves are at the entrance and the exit of the gate. They are both for the sliding screens made of closely wooven split bamboo or metal screening. These screens allow water to pass through freely but more or less successfully prevent the entrance of undesirable fishes, crabs, water snakes, and other aquatic enemies, and prevent the escape of the bañgos. The opening of the gate

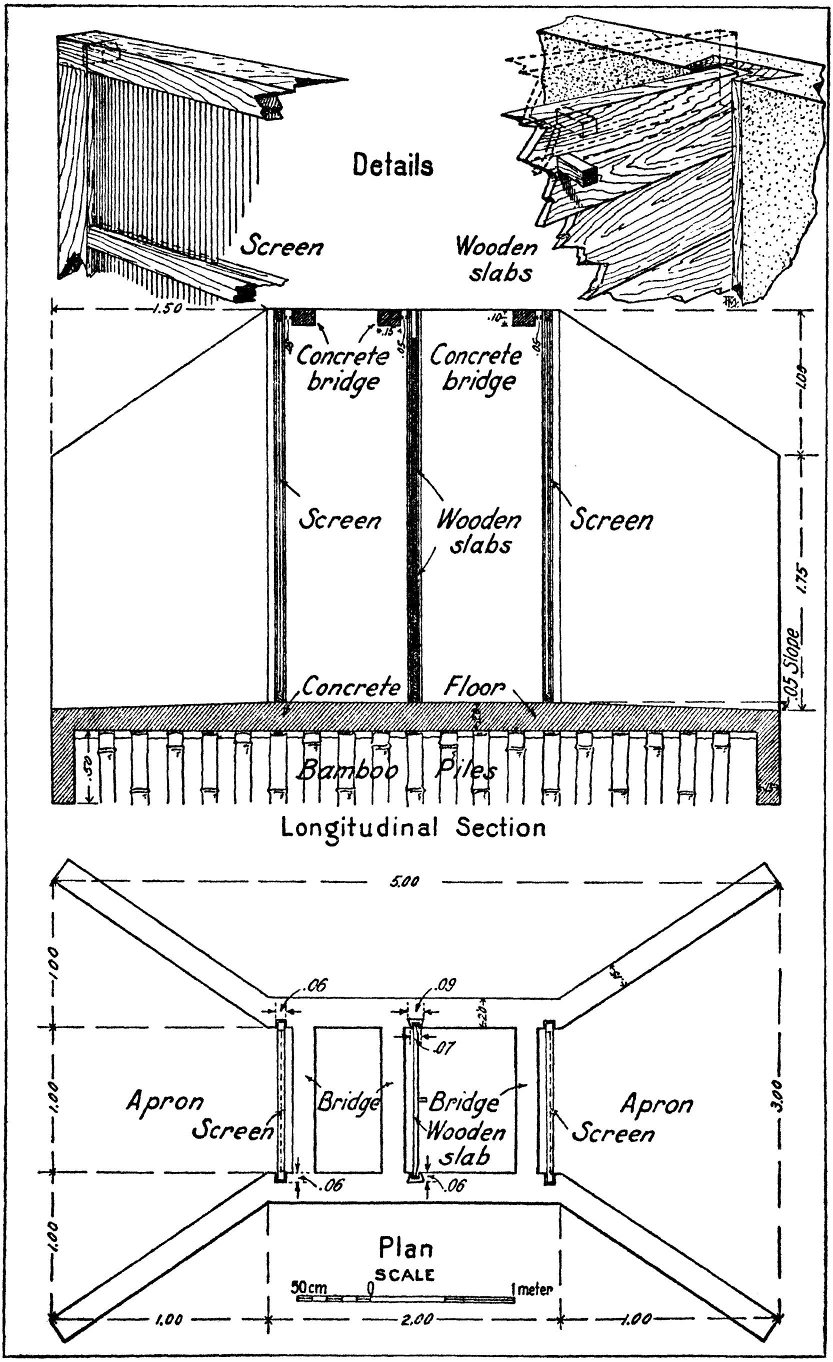


Fig. 3. Details of head gate.

is bridged at the top behind each pair of grooves to facilitate the work in setting or pulling of screens and slabs and to give additional strength to the structure.

In addition to the main gate or gates, it is necessary to have gates of smaller dimensions to allow water to pass to the different compartments; such as, the large rearing pond and the nursery. These gates, like the principal one, should be of concrete, and should have the sliding screens and boards.

Subdivisions.—A system of ponds for rearing bañgos from the fingerling stage to a marketable size includes kuluñgan, impitan or bansutan, and kaluañgan (figs. 4 and 5). The kuluñgan is a small subdivision, usually 15 to 20 meters in diam-

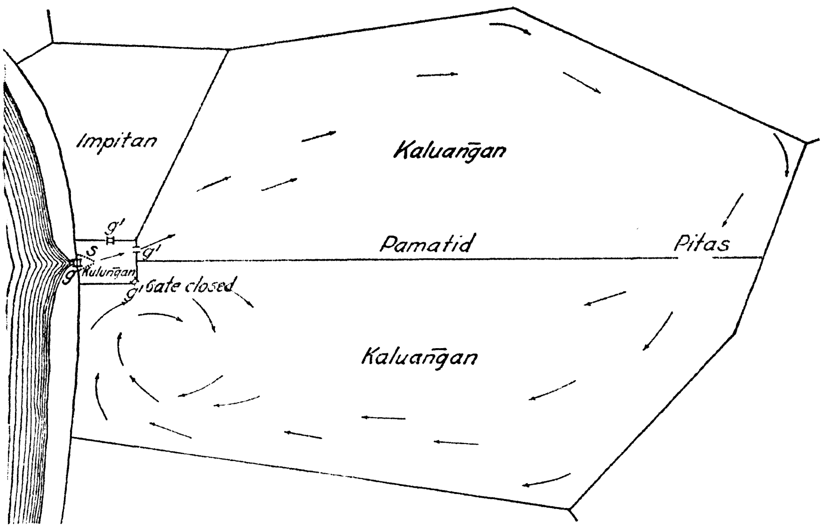


FIG. 4. Fish-farm layout; showing the effectiveness of pamatid in creating circulation of water in the kaluañgan; *g*, main gate; *g'*, gate of wood or concrete smaller than *g*; *s*, saplad.

eter, into which the water from the outside flows directly through the main gate (figs. 4 and 5, *g*). It is provided with smaller gates (figs. 4 and 5, *g'*). *S* in the same figures is the *saplad*, fashioned after a simple fish corral having two diverging walls like the letter V with the apex closed. Sometimes it is arranged in the form of a semicircle. It is used to prevent fish from swimming out of the kuluñgan when the gate is left open or in case the screens break. Properly speaking, the kuluñgan is the catching pond, but literally the word itself means "an inclosure."

The impitan has a triple purpose. Sometimes when only bañgos fry are available, they are placed in the impitan making

it serve as a fry pond, or pabiayan. It is used as a *palakihan* where the *hatirin* are allowed to grow to *garoñgin* size at which stage they are ready to be let loose in the kaluañgan. In case of an untimely shortage of lumut and where it is desired to produce two crops a year this subdivision serves as impitan proper, and also as bansutan, or retaining pond, where the fish are kept until a new supply of lumut grows in the kaluañgan and until the rearing pond is ready for the second crop.

The largest subdivision is the kaluañgan, or main rearing pond, where the fish coming from the nursery system are allowed to grow to marketable size.

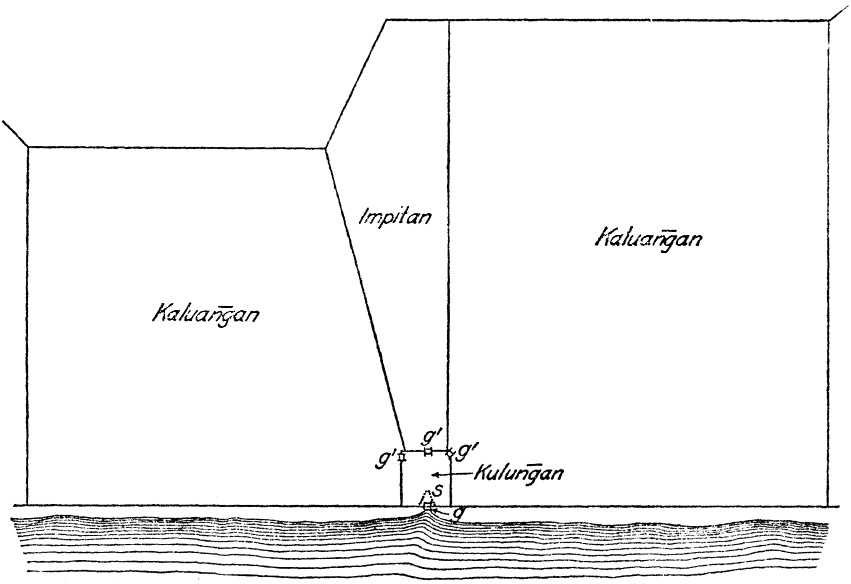


FIG. 5. Another type of fish-farm layout; *g*, main gate; *s*, saplad; *g'*, gate of wood or concrete smaller than *g*.

Canals.—Canals are as indispensable as the kuluñgan but should not be deeper than the latter. Drainage of the kaluañgan and impitan is made possible by sloping the bed of the canals at a sufficient grade to permit the water to empty through the gates into the kuluñgan. The canals are usually located across the greatest diameter of the pond and are deep enough to serve as resting places for the fish in the evenings and during hot days. If well dug and properly located they make good collectors during the catching season.

Pamatid.—The pamatid (from *patid,* meaning "to cut" or "short cut") is the dike that divides the kaluañgan into two

ponds. It serves a triple purpose. If the pond is large the pamatid serves as a shorter pathway to the farther end and either of the two subdivisions may serve for growing lumut in case the supply in the other is consumed. For this use the pamatid is provided with temporary gates, or *pitas,* which are closed after the fish have been transferred from one division to another. When the pitas is left open it allows the water to circulate and this freshens the pond water very effectively. It also serves to keep the lumut from being driven from place to place by the wind.

THE BAÑGOS FRY

Source of the bañgos fry.—Very little is known of the breeding habits of bañgos. It is supposed that they come to shallow sandy coasts to lay their eggs, which are of the floating type.

The very tiny, transparent, big-eyed bañgos fry, measuring 12 to 15 millimeters in length, swim in vast shoals near the shore line of shallow sandy coasts and enter estuaries and tidal creeks. They come in with the advancing flood tide and go out with the ebb, and, therefore, are always surrounded by fresh, cool, but shallow water. A knowledge of this fact is fundamental to the successful culture of bañgos.

In their natural habitat, it is not easy to distinguish these tiny bañgos from their common associates, such as, the fry of mullet (*banak*), tarpon (*buan buan*), and cutlass fish (*liwit*), which they closely resemble. A casual observer may find it almost impossible to differentiate one from the other. However, those who have acquired or developed through experience sufficient powers of discrimination are able to identify these creatures with a high degree of accuracy.

The capture of bañgos fry is a very important industry. The flat sandy coasts of Balayan and Batangas Bays, Batangas Province, furnish by far the largest quantity, and the annual license fees for catching the fry in this province amount to nearly 50,000 pesos. The fry captured are shipped to Malabon and other points around Manila Bay. Large quantities are also caught and shipped to Manila Bay growers from Mindoro, Marinduque, Tayabas, Sibuyan, Samar, Leyte, Tablas, Zambales, Pangasinan, La Union, and Ilocos Sur. Fishponds in the Visayan Islands are supplied with bañgos fry coming from Santa Rosa, near Mactan Island, and other points in Cebu Province, from Tanjay in Oriental Negros, from the southern portion of Iloilo Province, and from the coast of Antique, while the excess

catches are sent to Manila for distribution to bañgos-fry dealers and growers. Most of the shipments are made in native sailing boats, but a good many are sent by truck to some railroad point or steamer.

Methods of catching.—Two methods are employed in catching the fry. Along the shore, the *sayod,* or *sagap,* is used. This is a seinelike device made of coarse sinamay, measuring about 1.5 meters wide by 5 meters long. It is used in the same manner as any seine. Only two persons, one at each end, are needed to operate it. Two men keep dragging the seine until a large number of fry are caught.

The other method is by means of the saplad employed along the mouths of estuaries and tidal creeks. The saplad consists of two parts, the wings and the saplad proper which is a hammock-like net mounted on two bamboo frames. The two wings are set firmly in the ground in a V-shaped form, with the opening facing the sea. The point of intersection is left open for the fry to pass through into the saplad during the incoming tide. The wings are usually made of crushed bamboo (*tinidtid*) tied in place to a number of bamboo poles or stakes. This apparatus is set in shallow places where the water is up to about a meter in depth. It may be used to cover the entire width or only a portion of an estuary or tidal creek.

Sorting.—The fry are dipped from the sagap or the saplad by means of a basin, and before they are poured into earthenware jars the dirt is removed by means of a small bamboo brush (*cahig*) and the fry of other kinds of fishes are taken out. When the fry are few, sorting is done by picking out the undesirables by hand from the basin, but when there are so many that sorting by hand is impracticable, a sieve (*sala-an*) is used. It is an open-top rectangular box, two sides of which are made of wire netting, with the mesh of sufficient size to allow only bañgos fry to pass through. When in use, the sieve is placed on the sagap, which is kept partly immersed in water. The fry are then poured from the basin into the sieve. Those that pass through the sieve are held in the sagap, from which they are dipped up and placed in the jars.

Counting.—Counting the bañgos fry one by one is very tedious work, especially when there are many thousands of them. To facilitate this procedure the so-called *palyok* system is used. Persons engaged in the business always have at hand one thousand, or any counted number, of small pebbles or cowries (*sigay*). One man attends to the fry and another has the counters.

A clam shell or small bowl is used for dipping out the fry from one basin into another. After each dip the man calls out the number of fry in the dipper and the other man separates a corresponding number in counters from the counted heap of pebbles and sets them aside. The same process is repeated until the counted heap, say one thousand, is used up. Once counted, the density of the thousand fry as they appear in the basin is taken as a basis for the counting of succeeding thousands; thus, a basin of fry of approximately the same density as the first-counted batch will represent one thousand.

After the sorting and counting in the fishing ground, the fry are placed, as soon as possible, in low, wide-mouthed, pot-bellied, unglazed earthenware jars, palyok, which range from 15 to 30 liters in capacity. The jars are then covered, usually with leaf sheaths of the areca, or betel, palm.

Originally the water in the jars is sea water. However, it is gradually diluted with, or sometimes entirely changed to, fresh water as the jars stand in transit or waiting for buyers. Naturally, the fry coming from far-away places are weakened by their long journey in confined quarters. At Manila the fry are usually purchased by men from Malabon who make a business of handling and rearing them and supplying the fishponds. Some of the owners of the large fishponds receive their supply of fry directly from the fishing grounds.

On arrival at the market, as at Tutuban, the jars are carefully examined, and all dead fry removed. Usually from 5 to 10 per cent in each jar die in transit, and in the jars that are shipped long distances the mortality reaches 25 per cent. It is claimed that bañgos fry can stand, at most, fifteen days without feeding in jars half full of water. After the dealer has sorted the fry, the purchaser counts them. The counting is performed in the same manner as before. They are bought and sold by the ten thousand, or *lacsa,* and the price varies according to the season and place.

THE FRY-POND SYSTEM

The layout, construction, and operation.—The fry purchased by men from Malabon who make a business of handling and rearing them and of supplying fishponds in the provinces are taken to a place like Dampalit, where numerous nurseries or fry ponds are located. The fry ponds are so constructed that complete drainage of the water is possible. There is a gradation in the level of the floors of the different parts in the same

manner as in the large rearing ponds, or kaluañgan. A complete fry-pond system (fig. 6) in Dampalit consists of the pabiayan, where the bañgos fry are first placed and reared; the catching pond, or kuluñgan; and the canal, or *sangka*. The general characteristics of this system are small compartments, shallowness, low-partition dikes with small gates, and pipes, or *pansol*, for drainage and intake. The pipes are usually made of trunks of *Livistona* (*anahaw*). The pabiayan is the principal part of the system. Its floor should not be level, for in that case drainage would be difficult. In order to provide efficient drainage, a canal is usually made diagonally or sometimes lengthwise

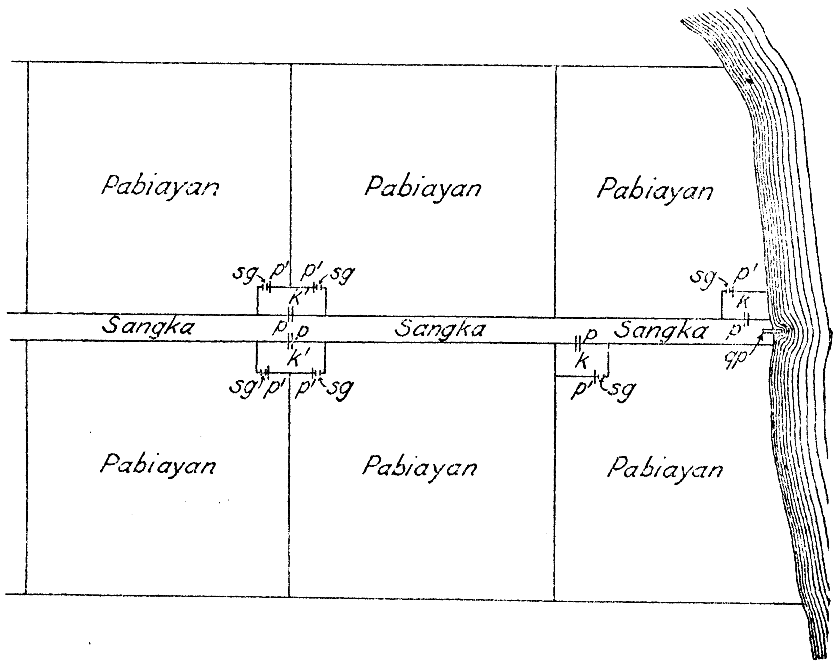


FIG. 6. Fry-pond system; *k-k'*, kuluñgan; *p-p'*, pansol; *qp*, quadrangular pipe; *sg*, small wooden gate.

across the pabiayan, and the bottom of the pond is so well graded that the water when released flows from all parts into the canal. The bed of the canal also slopes gradually, its deepest portion being at the end where it communicates with the gate of the kuluñgan as shown in fig. 6, *sg*. Besides facilitating drainage, the canal serves to collect young bañgos and lead them into the kuluñgan during the catching season, and also serves as a retreat for the fish during very warm periods. The partition dikes separating the compartments are usually about 60 centimeters in height.

The kulungan, *k* or *k'*, in the fry-pond system is used in the same manner as that of the ponds for larger bañgos. It is customary to locate it at one corner of the pabiayan—at either one of the corners adjacent to the sangka. If the pond is an irregular polygon, the corner chosen for the kulungan is the one from which the canal runs the longest diagonally. It is very necessary, however, that each pabiayan should have one kulungan. The general practice is to construct one or two adjacent regular polygonal ponds as shown in fig. 6, *k'*. This is done for economy of labor and mud. The same reason holds true in constructing kulungan at each corner as shown in *k*. In that case only two sides have to be constructed to make the subdivision. The kulungan should be deeper than the canal of the pabiayan.

Water is admitted into the kulungan by means of a pipe at *p*. Sometimes two pipes are employed, one set lower than the other and usually placed close to the floor. Both serve as drain and supply pipes. The lower pipe is called *pansimot* and is used to drain off the water completely at times when it is wanted to dry the pabiayan. A small gate, *sg*, usually of wood, is located at one corner of the kulungan. Another pipe, *p'*, is placed near this gate to serve as drain and supply tube for the pabiayan when the gate is temporarily closed with mud.

The sangka is a large canal about 1.5 meters at most in width. It is the deepest part of the fry-pond system, but should not be deeper than the river from which it gets the supply of water. Complete drainage is effected by having its bed slope gradually to one end, at which is constructed a gate or a large quadrangular pipe, *qp*, also called pansol. If this type of pansol is used, it is provided with a sliding board for regulating the flow of water and with screens at both ends to prevent the entrance of undesirable fishes. The sangka is used by some fry growers as kulungan for young bañgos of garongin size.

In operation, the water from the river flows into the sangka through the gate or pipe at *qp*. From the sangka it goes to the kulungan through one of the pipes at *p*, then to the pabiayan through the pipe at *p'*. In draining the pond, the water is let out through the same openings in the reversed order.

Food.—The proper and best food for the fry under cultivation is *lab-lab*. Lab-lab is the Tagalog name for the plant complex that under certain conditions forms a crust or mat upon the floor of the nursery pond. It is largely composed of unicellular, colonial, and filamentous blue-green algæ; it also contains a great variety of diatoms, bacteria, some unicellular green algæ,

a small proportion of very fine threads of filamentous green algæ, Protozoa, minute worms, and small crustaceans.

Before stocking the pabiayan with bañgos fry, the lab-lab is grown in order that a ready supply may be provided for the fish. Preparatory to its growing, the pond bottom is washed two or three times by allowing water to flow in and out freely. Water is admitted at high tide and then let out with the ebb. The pond is then exposed to the sunshine to dry for two or three days. This practice has two purposes; namely, to kill the enemies of the bañgos fry and to promote the growth of the lab-lab. When the bottom is sufficiently dry, water is turned in to a depth sufficient to cover the bottom, usually from 3 to 5 centimeters. In admitting water into the pond, care is taken that the pipe is covered with a *galao*, which is wrapped in fine-meshed sinamay cloth to serve as a screen. The object is to keep the other kinds of fishes from getting into the pabiayan before it is stocked with fry. The galao is an elongate, fine-

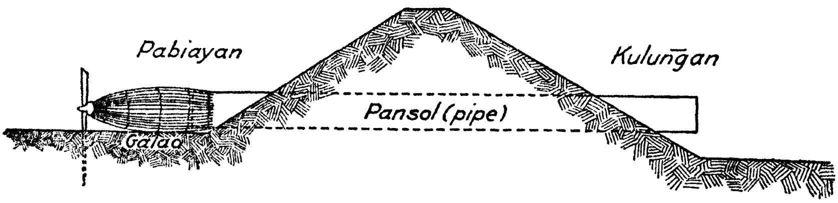


FIG. 7. Cross section of dike separating pabiayan from kuluñgan showing the position of pansol and galao.

meshed, woven-bamboo basket, shaped like certain types of fish trap, or *bobo* (fig. 7). Its size depends upon the size of the pansol. After three or four days a growth of lab-lab should appear on the bottom of the pond. The pond is not allowed to dry, and the water is maintained at a depth of 3 to 5 centimeters until the growth of lab-lab forms a dense, thick mat over the entire floor. Then the water is gradually increased to approximately 12 centimeters, but is not allowed to get deeper than this for filamentous algæ (*lumut, jusi*), which cannot be used by the tiny fry, will start to develop.

CARE OF THE YOUNG BAÑGOS IN THE NURSERY PONDS

Stocking of the ponds commences in May when the fry are available from the spawning grounds or the market. The pabiayan should be ready for occupancy when the jars of fry are delivered. To place the fry in the nursery, a jar is set in the water, tilted to one side, and the pond water allowed to

flow gently into it. The jar is then slowly and carefully turned over until the fry swim out.

Effect of temperature.—The temperature of the water in the pond is a matter of great importance. It must be cool and should be as nearly as possible of the same temperature as the water in the jars. As the jars are made of unglazed earthenware the constant evaporation of water through their pores keeps the water cool inside. Late afternoon or early morning is the best time for transferring fry from the jars into the pond.

Effect of weather conditions.—The first three or four days that the fry are in the nursery constitute the most critical period. If heavy rains fall during that time, the sudden change of temperature and salinity of the water causes a great mortality. The sediment carried down from the dikes by rain water may kill the fry by suffocation. On account of their weakened condition from their long journey in the jars, the fry are very susceptible to these conditions. It is, therefore, necessary to make careful observations of the weather and if rain threatens, the planting of the fry in the pabiayan should be delayed.

Care in preparing the pond for stocking.—The fry should be planted before the lab-lab starts to float, as they will die if they become entangled in it. Care should also be taken not to hurt the fry in planting. Before transferring the fry into the pabiayan, one should be sure that the pond is well washed with clean water to rid it of the old water that is highly saline as a result of constant evaporation. It is advisable to introduce new salt water from the river into the pond before the fry are planted.

The fry pond should be carefully watched to prevent the entrance of enemies, such as water snakes and carnivorous fishes. To a large extent the galao wrapped in sinamay cloth excludes most of them and at the same time prevents the tiny fry from escaping. At this time the small gate is temporarily closed with mud, but when the young bañgos have reached the fingerling stage this gate is used and the flow of water is controlled by means of the sliding boards. Water in the pond should be replaced now and then to prevent it from growing stale. When the fry are seen staying near the surface, it is a sure sign that the water is bad and needs changing. Sometimes the water in the river gets bad, and in this case auxiliary ponds to be used as reservoirs for fresh water are useful.

Some birds, like the herons and kingfishers, are very serious enemies of the bañgos fry. It is often necessary to post a watchman armed with a shotgun to kill or scare off such birds, especially around the newly established fishponds.

Number of fry required for stocking.—The number of fry to be raised in a pabiayan depends upon the growth of lab-lab. The number should be adjusted to the quantity of food available for the maintenance of the fish for a certain length of time. It has been estimated that a hectare of pabiayan with a good growth of lab-lab should not have more than 500,000 bañgos fry.

Catching, counting, and delivery of hatirin.—Hatirin are young bañgos of the fingerling size; that is, about 5 to 10 centimeters in length. The fry reach this size in about two to three months. The nursery ponds in the provinces are generally stocked with these from May to August. There is no definite time for catching the hatirin. Demand regulates when they are caught and delivered. They are collected in the kuluñgan and kept there for one day without food before delivery. This explains why lumut is not allowed to grow in the kuluñgan. The fish are then caught with a large fine-meshed seine (*panagap*), 6 to 8 meters long and 3 or 4 meters wide, which is employed to surround them. The hatirin are now scooped up from the panagap by means of cans and transferred into a large dip net (*bitinan*), which is kept partly immersed in water near the bank of the river so that the fish are always under water. The bitinan is supported at each corner by a bamboo pole driven vertically into the ground.

In counting, the fish are driven towards one end of the bitinan, and divided into two approximately equal portions by watching the density of the fish. One portion is let loose, and the other is divided into two equal parts. This process is continued until the number left can be counted easily. The last portion is then counted by means of the palyok system referred to previously and if it represents one-eighth of the total, the counted number is multiplied by eight to obtain the number of hatirin originally placed in the bitinan.

When the hatirin have to be transported long distances a large clean banca (*pamandawan*) is used. The boat is partly filled with clean salt water, and the fish are placed in it. Two screened holes in the banca provide circulation of water, and men bail constantly to keep the boat from sinking. If the distance is very great the banca is towed by a motor boat. Trans-

fer of the hatirin is usually done during the cooler part of the day.

At the place of destination the newly delivered fish are retained first in the impitan. This is a subdivision that can still be considered the nursery. Its size is governed by the size of the rearing pond, or kaluañgan, and it is used in fishpond systems that are dependent on nursery ponds, or pabiayan, in Dampalit and Navotas for their supply of young bañgos, or hatirin. A hectare of first-class impitan will carry about 15,000 to 18,000 hatirin until the large pond is ready.

Before the hatirin are ordered for planting in the impitan, it should be drained and left dry for from three to seven days, depending upon the weather. All snakes, mud skippers, and other enemies should be destroyed. Then the water should be turned in gradually to a depth of about 10 centimeters, which will start lumut growing all over the bottom of the pond, in small bunchy patches. As the lumut grows, the depth of the water is gradually increased. The little hatirin nibble away at the young lumut, and if the proportion is correct there will be sufficient feed for a time. In the meanwhile the large pond, or kaluañgan, should be prepared in the same way with a fine growth of lumut, for the hatirin are only kept in the impitan until the larger pond is ready for them.

In some places where the soil conditions are not favorable, it may be necessary to grow lumut by transplanting. First the pond is drained and well cleaned as previously described. Then water is turned in again to a depth of 10 centimeters, and clumps of lumut are planted. As soon as the new growth begins, the depth of water in the pond is steadily increased until the normal depth is reached. By that time there should be a sufficient growth of lumut so that fish may be turned into the pond.

The hatirin are usually kept two or three months in the impitan, to which they were transferred from the pabiayan. At the end of this period, they are 10 to 12.5 centimeters long and are called "garoñgin." The garoñgin are ready for planting in the large rearing pond if the growth of lumut is abundant. In case of an insufficient supply, the fish are simply retained longer in the impitan until the rearing pond is ready. A portion of the supply of garoñgin may be held in the impitan for a longer period as stock for the second crop, if it is desired to produce two crops in a year.

There is no fixed time for putting the garoñgin in the kaluañgan. Whenever one has a pond in proper condition and can get strong healthy garoñgin, then is the time to plant.

CARE OF THE GROWING BAÑGOS IN THE KALUAÑGAN

Stocking the kaluañgan.—The number of fish per hectare in ponds stocked for the market depends upon the condition of the pond. A pond in good condition with a luxuriant growth of lumut can carry from 1,000 to 1,500 hatirin or garoñgin per hectare till ready for the market.

Among beginners the commonest mistake is to overstock the pond. Overstocking results in heavy losses or even failure. The more fish in the pond the higher the percentage of deaths. The supply of lumut is soon exhausted, and the undernourished fish crowd one another so that they do not have room to exercise and develop properly. This results in the disposal of the bañgos long before they are large enough to bring a profitable price, or delays the harvest because the fish have to be transferred back to the bansutan until lumut can be grown in the kaluañgan. Sometimes a fishpond owner attempts to supply the lack of lumut in his pond by collecting lumut in the rivers or by buying it from other fishpond owners, but this practice cannot be relied upon.

Food of the bañgos.—The diet of bañgos under normal fishpond conditions is almost exclusively composed of filamentous green algæ, or lumut. As previously explained, the fry first feed upon lab-lab but gradually change their habits until they feed only on lumut. Where conditions are favorable the algæ grow in dense masses over large areas, frequently almost completely filling the pond.

Various hydrophytic flowering plants also occur in bañgos ponds, and the general name *digman* is applied to all of them. They thrive best in the rainy season when the salinity of the water in the ponds is reduced. Certain kinds of digman occur only in salt-water ponds, sometimes entirely covering the bottom, rooting in and creeping over the mud and remaining entirely submerged. When the salinity of a pond is very greatly reduced, duckweed, or *lia,* may appear and increase till it nearly covers the surface of the pond. The presence of lia under such conditions is an indication that the pond is not in good condition.

When bañgos are sick, instead of swimming in groups or small schools as is their habit, they usually scatter. They become sluggish and inactive in contrast to the healthy bañgos,

which are noticeable for their swift movements. When the pond cannot supply enough food, some people soak rice bran, or tikitiki, overnight till it sticks together, then place it on the bottom of the pond in small mounds for the bañgos to eat. Bañgos have been seen feeding upon grass projecting from the dikes into the water.

Freshening of pond water.—The freshening of the water in the ponds is as essential for the proper development of the bañgos as the care given to the repair of the dikes, the growing of algæ, the killing of enemies, etc. The pond water stales after a certain length of time and since it cannot be changed completely, once the pond is stocked with fish, it is merely freshened. In ponds with a single head gate, freshening is carried on by admitting water during high tide. The sluice is kept open until the tide starts to recede. The next day a portion of the pond water is let out through the same gate during ebb tide and new salt water from the river is allowed to flow in when the tide rises, as before. In large ponds having several gates, water should not be allowed to flow in and out through the same gates, as in this case the recently admitted water is thrown out. Gates on one side should be employed as supply gates and those opposite for outflow. In this way the freshening of the water can be handled more effectively and efficiently. Usually the ponds are freshened twice a month, during full and new moon when tides are high.

In freshening the water, care should be taken that the pond is drained slowly so as to give the fish time to go to the canals, thus preventing them from being stranded on the exposed portions in the pond. There should be a corral, or saplad, inside a kuluñgan behind the head gate as a precaution against fish escaping through the opening or jumping over the gate and dike. All the parts of the gate, however, should be properly set in admitting or letting out water.

The caretaker should see that all leaks in the ponds are stopped, and should always be on the lookout for holes bored by crabs, sea mantes, and sea scorpions.

Nipa palms in the pond.—In some places a few nipa palms are left growing in the pond to provide shade for the fish and to prevent the wind from blowing all the algal growth to one side.

RATE OF GROWTH OF THE BAÑGOS

The weight a bañgos should attain within a given length of time is unknown, as there are many factors that determine

the rate of growth. Some of the more important of these are the following:

1. The rate of renewal of the pond water, or the time elapsing between freshening the stale water with clear tidal water of the proper salinity.
2. The circulation of water within the pond system.
3. The amount of rainfall.
4. The sudden variations in salinity.
5. The character of the bottom soil of the pond.
6. The kind, the quality, and the quantity of food available per fish.
7. The size and depth of the stock ponds.
8. The number of fish to the hectare.
9. The number of other fishes living upon the same kind of food as that eaten by bañgos.

Hatirin let loose in the kaluañgan grow in size more rapidly than in the nursery ponds. This is due principally to the abundant growth of algæ, to the large pond, and to the great volume of water. It has been observed that the growth of the bañgos is slow during the period from January to April. This is attributed to several factors. As this is the dry season, the water in the fishpond is shallow and cannot be freshened often, hence the salinity and temperature are usually high so that the fish find themselves restricted in their movements and confined to places where the water is deep. They are also restricted in their feeding oftentimes since they cannot swim about freely to places where there is an abundance of lumut growth but where the water is usually shallow. During the rainy season, especially from August to October, their growth is very rapid. This is explained by the fact that the growth of lumut is also much faster during this period, hence there is greater abundance of algæ in the pond. Algæ seem to thrive well in fishponds where the water is brackish, especially during the rainy season. A greater depth of water enables the bañgos to go to the feeding grounds and to move around freely for exercise. Also, the temperature and salinity are such as to favor the proper development of the fish.

HARVESTING THE BAÑGOS

Harvest time in bañgos ponds varies widely according to the management and the locality. There are two plans in general use—namely, harvesting once a year and harvesting twice a year.

When the owner follows the method of harvesting bañgos twice a year, hatirin are placed in the kaluañgan during May or June and marketed from the end of September through Oc-

tober. Then the pond is drained, the ground prepared anew, and the pond restocked with garoñgin, which are harvested in April and May. The bañgos reared under this method reach a weight of 300 to 500 grams. Under this plan the owner should keep an impitan well stocked at all times with hatirin or garoñgin, ready to place in large empty ponds whenever they have been cleaned and have enough algæ to support the proper number of fish.

Under the other plan the fish are harvested during the latter months of the year when they weigh from 400 to 600 grams. The bañgos bring a higher price because they are comparatively larger.

Each method of growing and marketing bañgos has its advantages, and a fishpond owner should determine for himself which is the method best suited to the conditions in his locality.

CATCHING THE MARKETABLE BAÑGOS

During low tide, the water in the pond is reduced to about one-third, but at high tide water is again allowed to flow in. The water is so regulated in the kuluñgan that during catching time it is just about a meter in depth. As soon as the fish feel the inflowing current, they swim against it until they reach the catching pond. Here, they become eager to force their way against the gate, crowding one another half out of the water, and even leaping high in the air.

As soon as all the bañgos or as many as are wanted have entered the catching pond the gate between it and the kaluañgan is closed. The fish should then remain in the kuluñgan at least twenty-four hours before being caught. By that time the intestinal tract will be empty, and they will keep much longer than when caught at once while filled with food.

When sufficient time has elapsed, a seine (*saklit*) is dragged across the kuluñgan from end to end or from one side to another. During this operation there is great excitement. As the fish become crowded, they dart to and fro with great speed or leap high in the air. Frequently, they jump clear over the seine. Usually the seine is hauled to the bank and lifted section by section, the captured fish being placed in a banca. The pond is swept several times by the seine until all or practically all the bañgos are caught. Sometimes a gill net, called *kitid,* is also used to catch the bañgos in the kuluñgan. Only one man is required to handle this apparatus.

If the bañgos are placed in a banca they are transferred to large baskets when the boat is landed. The fish are

then laid out and sorted into standard sizes. All fish of other kinds, if any have been caught, are also placed in separate piles.

The fish are usually caught for market late in the evening or at night, so that they are in good condition for market the following morning. Around Manila Bay, the large producers put their bañgos in a motor boat, or in a large banca towed by a launch, and rush them to Manila, reaching there very early in the morning. Producers along the coast of Bataan pack their fish in ice and ship them to Manila on small local steamers. Fish from ponds at more-interior points in Bulacan and Pampanga and near railway stations are packed in ice and shipped by rail to adjacent provinces; such as, Tarlac, Pangasinan, Nueva Ecija, and Laguna. Some bañgos are also shipped by truck to neighboring towns.

Another method generally used for the capture of marketable bañgos in the Visayas is to construct a corral, or baclad, in the main pond, around the inner side of the gate. Sometimes it may be placed in the canal or creek outside the gate. If the baclad is outside the pond, the gate is opened at high tide when it is desired to catch fish. The bañgos swimming against the current pass through the gate and enter the baclad. As soon as the tide turns and the current slackens, the gate is closed, leaving the fish in the pound of the baclad. From this they are easily removed with a long-handled dip net. When the baclad is within the pond, doors are opened through which the fish can enter at high tide. These doors are closed at low tide, thus confining the fish within the baclad.

NATURAL ENEMIES OF THE BAÑGOS

Fish enemies.—It is very difficult to prevent the entrance of other kinds of fishes into bañgos ponds. Not only are certain kinds found mixed with the bañgos fry in the earthenware jars, but the young of many other kinds pass through the meshes of the bamboo screens when fresh salt water is admitted at high tide. Large fishes of certain kinds may be introduced carelessly and often produce eggs at once, which soon hatch into a horde of ever-hungry carnivorous fry. If the pond is near a bay or other large body of salt water, the killifish (*bubuntis*), gobies (*bia*) of many kinds, several species of eels (*igat, palos,* and *malabanos*), ambassid (*lañgaray*), spadefish (*kitang*), tarpon (*buan-buan*), sea bass (*apahap* and *lapo-lapo*), slip-mouth (*sap-sap*), halfbeak (*cansusuit*), grunt (*bagaong* and *ayuñgin*), ten-pounder (*bid-bid*), and other kinds are found in abundance.

Where the pond is at some interior point where it is flooded by fresh or only slightly brackish water, mudfish (*dalag*) and climbing perch (*liwalo*) are almost sure to enter. Most of the moderately small fishes referred to above are destructive to the kawag-kawag, hatirin, and garoñgin stages, but the others like the buan-buan, dalag, apahap, and other species of sea bass that grow to a larger size do much more harm to bañgos at all stages of growth.

Other enemies.—Among birds that feed upon young bañgos are egrets (*tagak*), terns (*kalañgay*), kingfishers (*kasay-kasay*), bitterns (*bakaw*), and the white-breasted sea eagle (*lawin*). Where the water in the pond is of low salinity, frogs may be found. These are harmful to the growing bañgos in the nursery pond. Several species of water snakes get into the fishponds through the gates and by crawling over the dikes. The commonest are *Disteira ornata* (Gray), *kalabukab*, and *Chersydrus granulatus* (Schneider), *malabasahan*. The snakes play havoc with the bañgos.

DESTRUCTIVE CRUSTACEANS FOUND IN THE FISHPONDS

Several kinds of shrimps usually occur in large quantities in bañgos ponds, especially the kind known as *sugpo*. Shrimps do no harm if they are not allowed to enter the nursery pond. Several species of crabs are found in bañgos ponds, and if of the best marketable kind may bring considerable revenue to the fishpond owner. In spite of the fact that crabs may contribute to the income, their presence in a bañgos pond is a source of more expense than revenue. They burrow holes in the dikes causing much loss of water and allowing water snakes, eels, dalag, and other enemies to get into the fishpond. Other burrowing crustaceans very harmful to fishpond dikes are sea mantes (*pitic-pitic*), sea scorpions (*oson*), and fiddler crabs (*bañgi-bañgi*).

CATCHING SHRIMPS

Of the aquatic animals that enter the ponds through the gates, the shrimps are the most welcome. They contribute to the income and their presence in a bañgos pond is a source of revenue.

Shrimps are attracted by light. When high tide occurs in the evening, water is admitted into the pond. Caretakers take this opportunity to let in as many shrimps as can be attracted to the gate by a fisherman's reflecting lamp suspended from the

bridge of the gate. The shrimps are carried inside the pond by the incoming water.

The usual method of admitting water into the pond is to allow it to flow over the top of the planks, but when shrimps are to be introduced the planks are raised, allowing the water to come in from below. The planks do not fall but are held in their respective positions by the lateral pressure of the water. The velocity of water is so great that shrimps lingering in the neighborhood of the gate are forced into the pond. This method has proved very effective with shrimps, which are known to be bottom swimmers.

Small traps modelled after large fish corrals but made especially for shrimps are set inside the ponds. They are known as *bakikong* or *umang*. The leader (*painpin*) is set at right angles to the dike which it touches. The umang is made of baclad or woven split bamboo. The shrimps are caught in the pound by a dip net provided with a long pole.

POSSIBILITY OF CULTIVATING MULLET, OR BANAK, WITH BAÑGOS

There are about twenty kinds of mullets in Philippine waters; some are exclusively marine, but most of them occur in both fresh and salt water. Like the bañgos they are practically toothless and feed largely upon organisms contained in the surface layer of bottom mud, as well as upon algæ. They are sometimes mistaken for bañgos, but are at once distinguishable by having two dorsal fins as well as a broad snout.

Mullets are represented by two groups in the Philippines. Those with the eye covered by a thick transparent tissue, called the adipose eyelid, belong to the genus *Mugil;* the others, coming under the genus *Liza,* are distinguished by not having an adipose eyelid. Some Philippine species have no commercial value because of their small size, but one species, *Mugil cephalus* Linnæus, or gray mullet, which reaches a considerable size, has been known to be cultivated extensively and successfully in India, Japan, Formosa, and other Oriental countries. The sides of this fish are marked by dark but not very evident longitudinal stripes along the rows of scales. The gray mullet is very common in the Philippines. It is much superior to bañgos in flavor and is free of fine bones, and being a strict vegetarian should thrive in the same pond with bañgos. As has been observed in some fishponds in Japan and Formosa, the gray mullet can be fed with prepared food; such as, sweet potato (*camote*), rice bran, etc.

A MODEL TEN-HECTARE FISH FARM

The size and shape of a fish farm are governed by the area and the configuration of one's property. Established practice requires certain definite proportions in the size of the ponds. A fish farm of about 10 hectares should have four ponds; namely, the kuluñgan, pabiayan, impitan, and kaluañgan (figs. 8 and 9). The impitan should be made about one-tenth of the whole farm, or 1 hectare. The pabiayan is but a small portion of the impitan, and it should cover one-seventeenth to one-twentieth of its

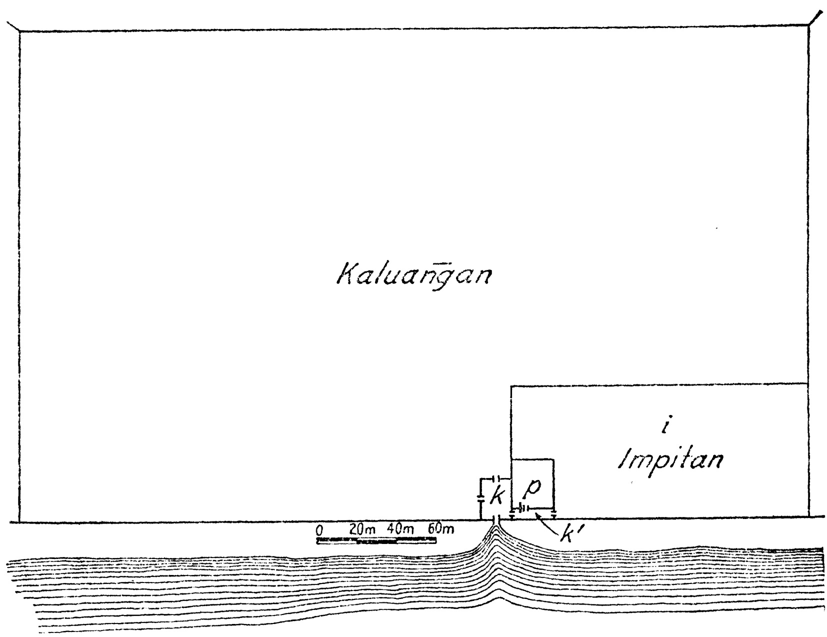


FIG. 8. Plan of ideal 10-hectare fish farm (400 by 250 meters); *k*, kuluñgan; *k'*, kuluñgan for ponds *p* and *i*; *p*, pabiayan.

area. A space of about 300 square meters is the proper size for the kuluñgan. The rest of the 10 hectares is the kaluañgan.

As has been previously stated, a hectare of pabiayan can carry 500,000 bañgos fry at one time, or 50 fish to a square meter. A 10-hectare fish farm should have a pabiayan that will accommodate from 25,000 to 30,000 fry for stock. Allowing 40 per cent mortality in the pabiayan due to the havoc caused by enemies and to the varying effects of the physical factors during the period of acclimatization, the number of fingerlings that can survive is from 15,000 to 18,000. The young fish are then transferred into the impitan, where they are either retained for an indefinite period or allowed to grow sufficiently large to with-

stand adverse conditions in the kaluañgan. In the impitan the fish enemies are more or less under control, as in the pabiayan, and because of the larger size of the growing bañgos and their ability to escape readily from their enemies, the mortality is much less, usually not over 15 per cent. After making due allowance for mortality, the number that can be carried into the kaluañgan is from 12,500 to 15,000. On account of the presence of enemies of different kinds and sizes, and of other destructive factors, the mortality in this pond may be as high as 30 per cent so that the number of bañgos harvested would be from

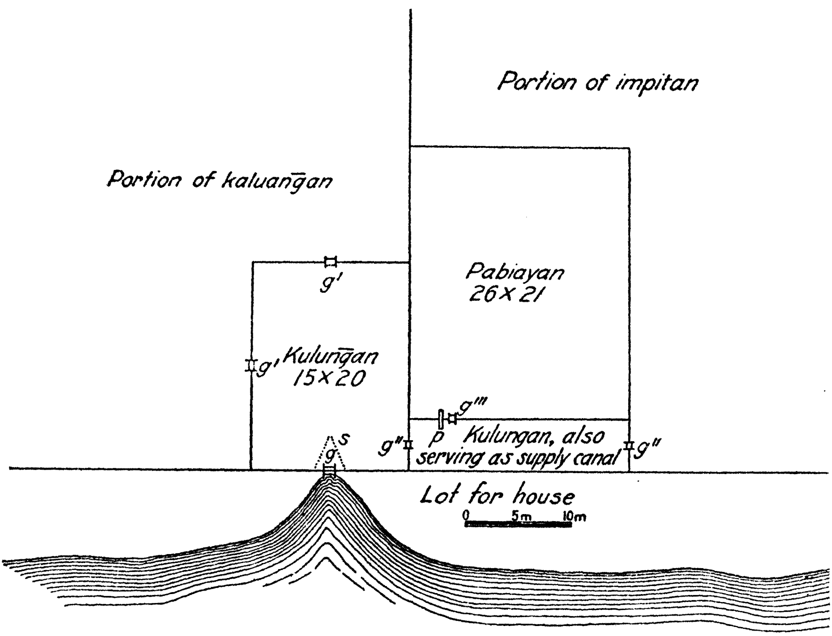


FIG. 9. Details of kuluñgan and pabiayan; *g*, main gate; *s*, saplad; *g'*, secondary gate; *g''*, gate of wood or concrete smaller than *g'*; *g'''*, gate of wood smaller than *g''*; *p*, pansol.

9,000 to 11,000, or 900 to 1,100 per hectare. From the above figures, it is advisable that in order to obtain the best results the number of bañgos fry used for stocking a 10-hectare fish farm should not exceed 30,000.

In the case of smaller farms, the pabiayan can be done away with. The impitan properly prepared will serve the purpose. In a fish farm of less than a hectare, the kuluñgan, impitan, and pabiayan are not necessary if the stock available consists of fingerlings. Where the supply consists only of fry, it is

advisable to have at one corner a small nursery of only one compartment.

GLOSSARY

ALGÆ. Organisms belonging to the lowest division of the vegetable kingdom, comprising seaweeds, pond scums, and a great variety of plants invisible to the naked eye inhabiting fresh and salt water in countless numbers.

AMBASSID. Small translucent fish, called lañgaray in Tagalog, destructive to young bañgos in the nursery ponds.

ANAHAW. Local name for *Livistona*, a kind of palm, the trunk of which is used for supply and drain pipes in the nursery ponds.

APAHAP. *Lates calcarifer* (Bloch), a member of the sea bass family, the worst enemy of the bañgos, being voracious and carnivorous.

APRON. A continuation of the floor of a headgate at each side to prevent undercutting of water.

AWA. Ilocano, Visayan, and Pangasinan name for full-grown bañgos.

AWA-AWA. Visayan name for bañgos fry.

AYUÑGIN. Tagalog name for grunt, *Therapon argenteus* (Cuvier and Valenciennes), a species occurring both in salt and fresh water, and destructive to bañgos fry.

BACTERIA. Extremely minute organisms, occurring as refuse eaters and as parasites.

BAGAONG. A grunt, *Therapon jarbua* (Forskål), a fish harmful to young bañgos.

BAKAWAN. Tagalog name for mangrove.

BAKAW. Tagalog name for bittern, a bird harmful to bañgos.

BAKIKONG. Trap to catch shrimps; also called umang.

BANAK. Tagalog name for mullet, a kind of fish entering fishponds and possessing habits similar to the bañgos.

BAÑGI-BAÑGI. Visayan name for fiddler crab, a burrowing crustacean destructive to fishpond dikes.

BANGLIS. Tagalog name for bañgos.

BAÑGILIS. Samal and Tao Sug name for bañgos.

BANGLUS. Visayan name for bañgos.

BANGRIS. Tagalog name for bañgos.

BAÑGOS. Tagalog, Ilocano, Pampango, and Bicol name for milkfish.

BANGROS. Visayan name for bañgos.

BANSUTAN. The second or largest compartment in a nursery system where young bañgos, or hatirin, are retained for two months or longer until they are large enough for planting in the kaluañgan, or rearing pond.

BERM. Space between the dike and borrow pit.

BETEL. Pangasinan name for bañgos.

BIA. Tagalog name for goby, which refers to small carnivorous fishes of the family Gobiidæ, destructive to young bañgos.

BID-BID. Ten-pounder, *Elops hawaiiensis* Regan, a swift, rapidly growing, voracious, carnivorous fish very destructive to bañgos.

BITINAN. A dip net, usually rectangular in shape, partly immersed in water, where hatirin, or fingerlings, are counted.

BITTERN. A bird, called bakaw in Tagalog, destructive to young bañgos.

BOBO. A fish trap, basketlike affair, made of woven bamboo splints.

BORROW PIT. Marginal canal in the fishpond from which mud is taken to make the dike.

BUAN-BUAN. Tarpon, *Megalops cyprinoides* (Broussonet), a voracious and carnivorous enemy of the bañgos.

BUBUNTIS. Tagalog name for killifish, *Mollienisia latipinna* Le Sueur, an introduced species harmful to young bañgos by feeding on the same kind of food.

BUGUI. Ilocano name for bañgos fry.

CAHIG. Visayan name for a small brush used to remove dirt from the basin containing bañgos fry.

CAMOTE. Sweet potato.

CANSUSUIT. Tagalog name for halfbeak.

CHANOS CHANOS. Scientific name of bañgos.

CHERSYDRUS GRANULATUS. Scientific name of a species of water snake, called malabasahan in Tagalog.

COLONIAL. Of, pertaining to, or being a colony or colonies.

COWRIE. A kind of sea shell, known locally as sigay.

CRUSTACEA. A class of animals to which crayfish, lobsters, shrimps, prawns, crabs, and the like belong.

CUGAO. Visayan name for bañgos.

DALAG. Tagalog name for mudfish, *Ophicephalus striatus* Bloch, one of the most dangerous enemies of the bañgos, being voracious and carnivorous.

DIATOMS. A class of one-celled algæ inhabiting fresh and salt water.

DIGMAN. Tagalog name applied to various hydrophytic plants occurring in fishponds.

DISTEIRA ORNATA. Scientific name of a species of water snake, called kalabukab in Tagalog.

EAGLE. A bird, called lawin in Tagalog, destructive to bañgos.

EEL. A snakelike fish, known locally as ogdoc, igat, or palos, which enters fishponds and feeds on young bañgos.

EGRET. A bird, called tagak in Tagalog, destructive to bañgos.

FIDDLER CRAB. A crustacean, called bañgi-bañgi in Visayan, destructive to fishpond dikes.

FILAMENTOUS. Like, consisting of, or bearing threads or filaments.

FINGERLING. Young bañgos fingerlike in size, called hatirin and garoñgin in Tagalog, which vary in length from 5 to 12.5 centimeters.

FRY. Very young bañgos, called kawag-kawag or kakawag in Tagalog, taken along the coasts in many parts of the Islands for planting in fishponds; known also as bugui, awa-awa, and semilla.

GALAO. An elongate, fine-meshed, woven-bamboo basket, shaped like certain types of fish traps, or bobo, wrapped in sinamay cloth to serve as a screen with the object of keeping the enemies of young bañgos out of the nursery.

GAROÑGIN. Tagalog name for young bañgos of fingerling size, usually 10 to 12.5 centimeters long.

GOBY. Small carnivorous fish of the family Gobiidæ, called bia in Tagalog, destructive to young bañgos.

HALFBEAK. Fish with produced snout, the upper part of which is much shorter than the lower, called cansusuit in Tagalog; harmful to young bañgos.

HATIRIN. Young bañgos of fingerling size, usually 5 to 10 centimeters long.

HYDROPHYTIC. Living in water; pertaining to plants living in water.

IMPITAN. The largest subdivision in a nursery system where the young bañgos, or hatirin, are held about two months or longer until large enough for planting in the kaluañgan, or rearing pond.

IGAT. Fresh-water eel.

KAKAWAG. Tagalog name for bañgos fry.

KALABUKAB. A water snake, *Disteira ornata* (Gray), destructive to bañgos.

KALAÑGAY. Tagalog name for tern, a bird harmful to young bañgos.

KALUAÑGAN. The rearing pond where bañgos are allowed to grow to marketable size.

KASAY-KASAY. Tagalog name for kingfisher, a bird destructive to young bañgos.

KAWAG-KAWAG. Tagalog name for bañgos fry.

KITANG. A well-flavored fish, *Scatophagus argus* (Gmelin), abundant in rivers and estuaries, sometimes found in fishponds; being vegetarian it does no harm to the bañgos and its presence is not objectionable.

KITID. A small gill net used to catch marketable bañgos in the kuluñgan.

KULUÑGAN. The catching pond.

LAB-LAB. Tagalog name for the plant complex forming a crust or mat upon the floor of the nursery pond, composed largely of unicellular, colonial, and filamentous blue-green algæ; it contains also diatoms, bacteria, some unicellular and filamentous green algæ, many Protozoa, minute worms, and small Crustacea.

LAÑGARAY. Tagalog name for ambassid, a small and very bony, semitransparent, silvery fish destructive to bañgos fry.

LAON. Name referring to bañgos, especially to the fish that have remained a year or longer in the fishpond.

LAPO-LAPO. Sea bass, one of the worst enemies of the bañgos.

LAWIN. The white-breasted sea eagle, an enemy of the bañgos.

LIA. Duckweed, a kind of floating water plant found in some fishponds.

LIVISTONA. The generic name of a palm, the wood of which, called luyong in Tagalog, is used for supply and drain pipes in the nursery ponds.

LIWALO. The climbing perch, *Anabas testudineus* (Bloch), a harmful enemy of young bañgos.

LIZA. Generic name of a group of mullets having no adipose eyelid.

LUMULUKSO. Tagalog name for full-grown bañgos noted for their astounding leaping powers.

LUMUT. Filamentous algæ.

MALABANOS. Marine eel; a moray.

MALABASAHAN. A species of water snake, *Chersydrus granulatus* (Schneider), harmful to bañgos.

MECHA. Puddle trench, or trough, dug in the middle of the main dike along its entire course.

MORAY. A kind of marine eel.

MUDSKIPPER. A kind of goby, called talimosak in Tagalog, that feeds on bañgos fry.

MUGIL. Generic name of a group of mullets possessing an adipose eyelid.

MUGIL CEPHALUS. The scientific name of the gray mullet.

MULLET. A fish sometimes mistaken for bañgos; strictly vegetarian, living largely on the minute organisms contained in the layer of mud at the bottom of the nursery pond.

OSON. Visayan name for sea scorpion, a crustacean boring holes through fishpond dikes.

PABIAYAN. The first small compartment in the nursery system, where bañgos fry are reared for the first month or six weeks.

PAINPIN. The leader of the trap used to catch shrimps in fishponds.

PALAKIHAN. Another name for impitan or bansutan.

PALAPAT. Tagalog name for a tree, *Sonneratia*, growing in mangrove swamps.

PALOS. Tagalog name for marine snake eel.

PALYOK. The low, wide-mouthed, pot-bellied, unglazed, earthenware jar used as a container for the transportation of bañgos fry.

PAMANDAWAN. Large boat, or banca, employed to transport bañgos fingerlings from the nursery ponds in Dampalit to fishponds in other localities.

PAMATID. Partition dike dividing a rearing pond into two or more compartments.

PANAGAP. A fine-meshed seine of cotton, similar to the sagap, employed to catch hatirin.

PANSIMOT. The lower of the two pipes in the pabiayan, which is used to drain the water off completely when it is desired to dry the pond.

PANSOL. Pipe made of the trunk of the anahaw palm, *Livistona*, employed in the nursery ponds for drainage and intake.

PATID. To cut or short cut.

PITAS. Temporary gate cut at certain portion in the partition dike used as passage for fish from one compartment to another.

PITIC-PITIC. Visayan name for sea mantis, a burrowing crustacean destructive to fishpond dikes.

POLYGON. A plane or closed figure having more than four angles.

PROTOZOA. A primary division of the animal kingdom, embracing organisms consisting of a single cell or groups of cells not separable into different tissues.

PUDDLE TRENCH. A trough, or "mecha," dug in the middle of the main dike along its entire course.

QUADRANGULAR. Having four sides and four angles.

SABALO. Full-grown bañgos; lumulukso.

SAGAP. A small seine of sinamay, employed to catch bañgos fry.

SAKLIT. A large seine employed to catch marketable bañgos in the kuluñgan.

SALA-AN. A sieve of wire netting, used to separate bañgos fry from the fry of other fishes.

SANGKA. A canal in the fry-pond system.

SAPLAD. A trap similar to the fish corral, or baclad, employed to catch bañgos fry.

SAP-SAP. Small, silvery fish, very much compressed, and able to protrude the mouth to a remarkable extent; found sometimes in fishponds.

SAYOD. Ilocano name for the small seine, or sagap, for catching bañgos fry.

SCATOPHAGUS. Generic name for kitang.

SEA MANTIS. A burrowing crustacean, destructive to fishpond dikes; known as pitic-pitic in Visayan.

SEA SCORPION. A burrowing crustacean, destructive to fishpond dikes; called oson in Visayan.

SEMILLA. Local name for bañgos fry.

SIGAY. Local name for cowrie; used for counting bañgos fry.

SINAMAY. Native cloth made of abacá fiber.

SLIP-MOUTH. Known locally as sap-sap; a small, silvery, and compressed fish, able to protrude its mouth in a singular manner.

SONNERATIA. A kind of tree growing in mangrove swamps, called palapat in Tagalog.

SPADEFISH. A dark-spotted, deep-bodied, much-compressed fish, called kitang in Tagalog.

SUGPO. A kind of shrimp entering fishponds.

TAGAK. Tagalog name for egret, a bird harmful to young bañgos.

TALIMOSAK. A kind of goby destructive to young bañgos, common in mud flats, mangrove swamps, and muddy estuaries; well known for its leaping powers.

TEN-POUNDER. Known as bidbid in Tagalog, or *Elops hawaiiensis* Regan, a very destructive enemy of the bañgos.

TERN. A bird, called kalañgay in Tagalog, harmful to bañgos.

TIKITIKI. Rice bran.

TINIDTID. Crushed bamboo employed in fish trap, or saplad, for catching bañgos fry.

UMANG. Small trap modelled after a fish corral, used for catching shrimps; also called bakikong.

UNICELLULAR. Consisting of a single cell; one-celled.

ILLUSTRATIONS

PLATE 1

Bañgos, or milkfish, *Chanos chanos* Forskål; about × 0.5.

PLATE 2

FIG. 1. Bañgos fry, or kawag-kawag; × 8. Actual length, 10 millimeters.

2. Roe of bañgos containing over 3,000,000 eggs.

PLATE 3

FIG. 1. Catching bañgos fry with sagap. Barrio Calala, San Jose de Buenavista, Antique Province.

2. Another view showing catching of bañgos fry with sagap. Barrio Calala, San Jose de Buenavista.

PLATE 4

FIG. 1. Catching bañgos fry with saplad. Barrio Calala, San Jose de Buenavista.

2. Counting bañgos fry. Barrio Calala, San Jose de Buenavista.

PLATE 5

FIG. 1. Bañgos fry in earthenware jars ready for sale. Barrio Calala, San Jose de Buenavista.

2. Fishpond site cleared of nipa palms and mangrove trees. Pilar, Bataan Province.

PLATE 6

FIG. 1. Catching shrimps in corral inside pond.

2. Partial view of fish farm showing pabiayan in the foreground, impitan at the left, and kaluañgan in the foreground. Orani, Bataan Province.

PLATE 7

FIG. 1. Fish farm at Balamban, Cebu Province.

2. Fry-pond system showing a series of six pabiayan and canal. Orani, Bataan.

PLATE 8

FIG. 1. Fishpond with an excellent growth of algæ. Carlos Palanca estate, Hagonoy, Bulacan Province.

2. Banca load of jars of bañgos fry towed by motor boat from Manila to the Carlos Palanca estate, Hagonoy, Bulacan Province, and Masantol, Pampanga Province.

PLATE 9

FIG. 1. Discarding dead bañgos fry and making the number of fish uniform in the various jars. Carlos Palanca estate, Hagonoy and Masantol.

2. Catching young bañgos (garoñgin). Net (bitinan) is not lifted from the water. Fish are released in the large pond as counted. Ayala estates, Macabebe, Pampanga Province.

PLATE 10

FIG. 1. Constructing a dike. Camus Brothers' fish farm, Dagatdagatan, Caloocan, Rizal Province.

2. Repairing dike. Camus Brothers' fish farm, Dagatdagatan, Caloocan.

TEXT FIGURES

FIG. 1. Cross section of main dike showing puddle trench, berm, borrow pit, and floor of pond.

2. Schematic sketch showing kuluñgan, head gate, saplad, and secondary gate in background.

3. Details of head gate.

4. Fish-farm layout, showing the effectiveness of pamatid in creating circulation of water in the kaluañgan; *g*, main gate; *g'*, gate of wood or concrete smaller than *g*; *s*, saplad.

5. Another type of fish-farm layout; *g*, main gate; *s*, saplad; *g'*, gate of wood or concrete smaller than *g*.

6. Fry-pond system; *k-k'*, kuluñgan; *p-p'*, pansol; *qp*, quadrangular pipe; *sg*, small wooden gate.

7. Cross section of dike separating pabiayan from kuluñgan showing the position of pansol and galao.

8. Plan of ideal 10-hectare fish farm (400 × 250 meters); *k*, kuluñgan; *k'*, kuluñgan for ponds *p* and *i*; *p*, pabiayan.

9. Details of kuluñgan and pabiayan; *g*, main gate; *s*, saplad; *g'*, secondary gate; *g''*, gate of wood or concrete smaller than *g'*; *g'''*, gate of wood smaller than *g''*; *p*, pansol.

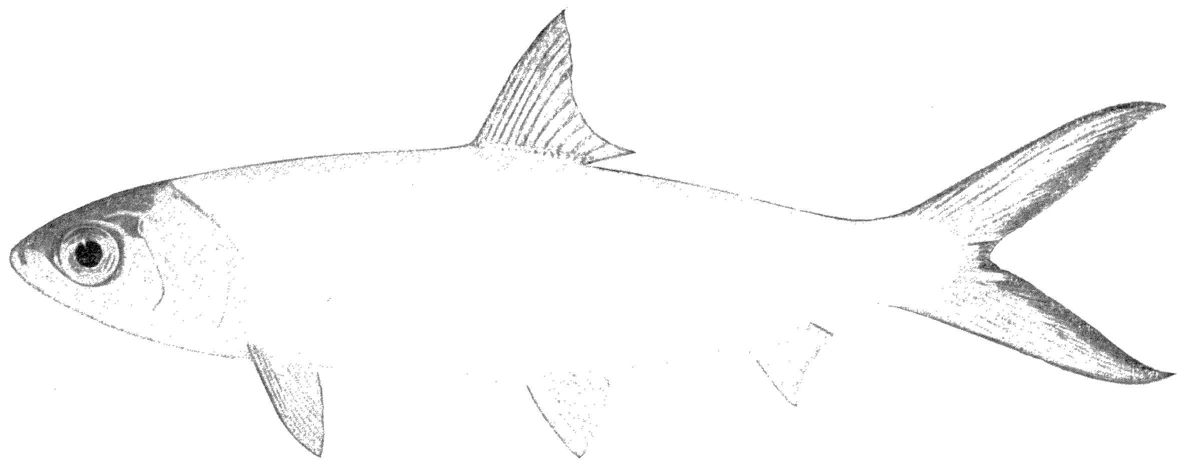
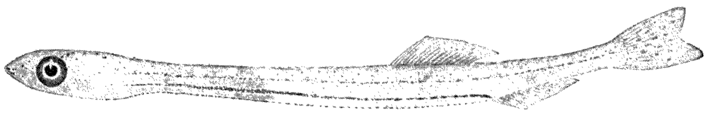


PLATE 1. BAÑGOS, OR MILKFISH, CHANOS CHANOS FORSKÅL.



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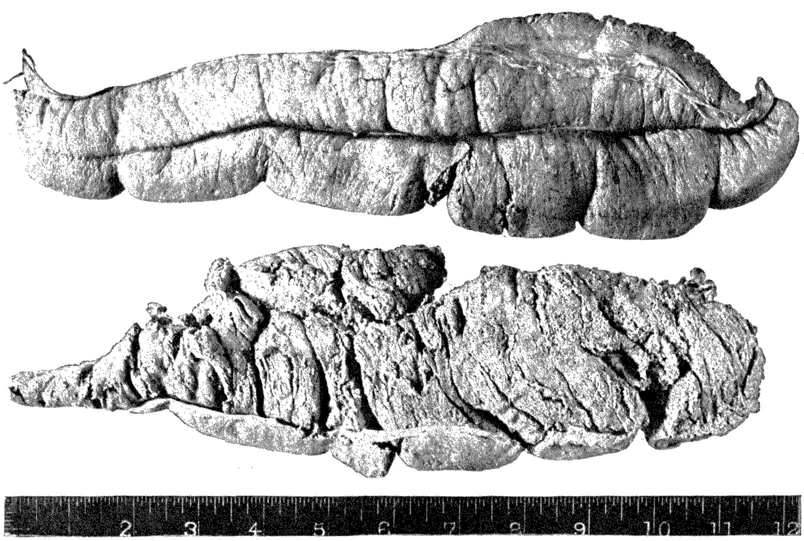

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PLATE 2.

1

2

PLATE 3.

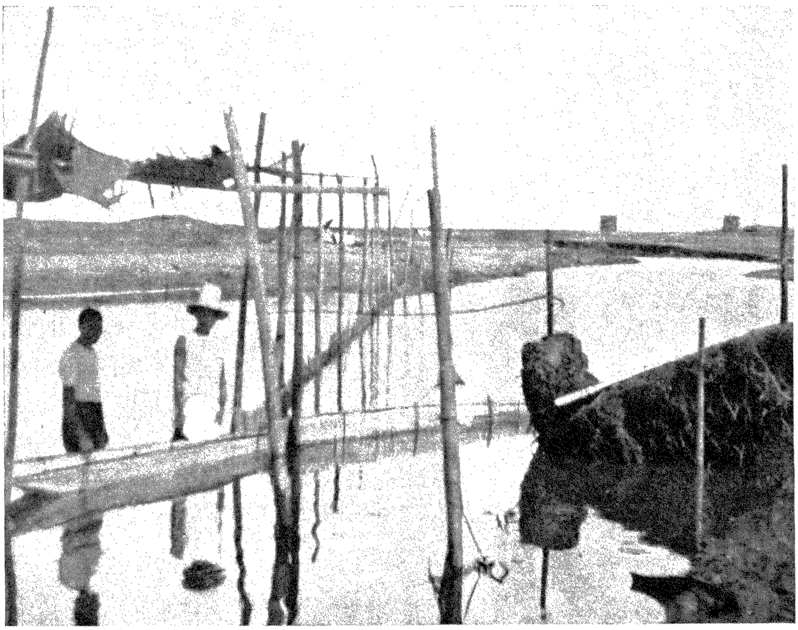

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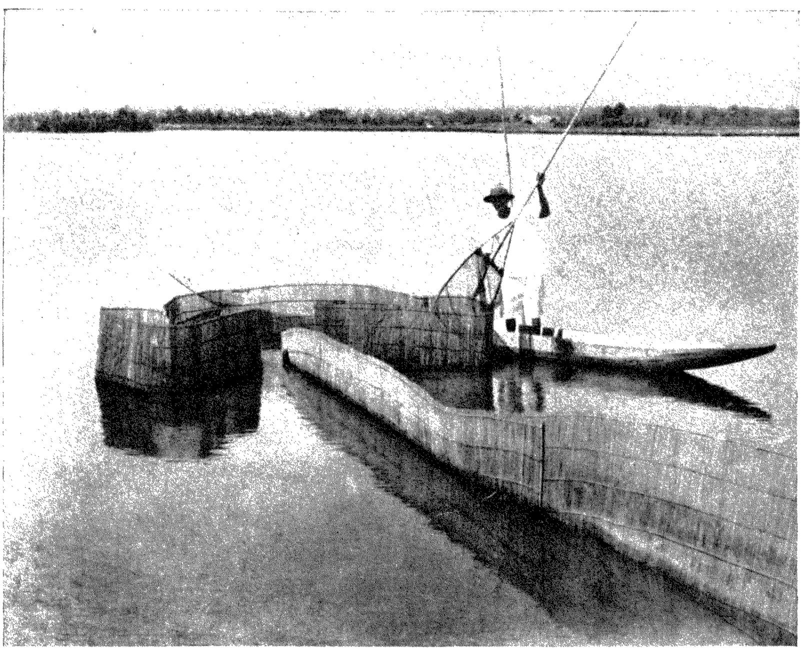
PLATE 4.

1

2

PLATE 5.



1

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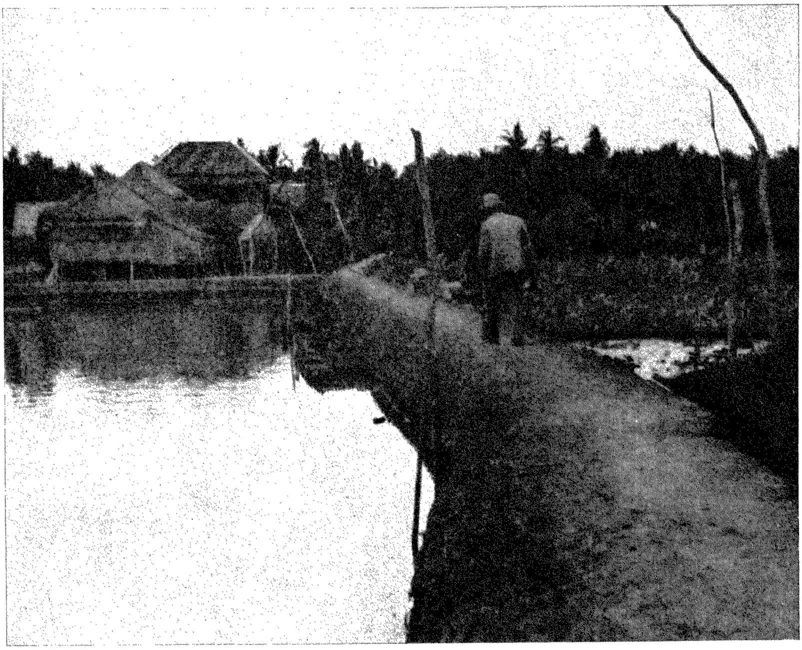
PLATE 6.



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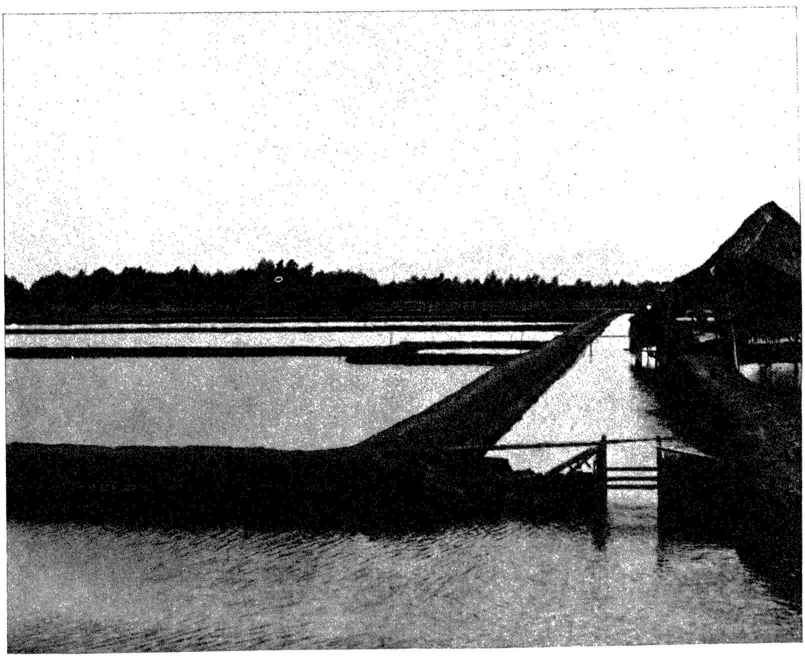

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PLATE 7.

1

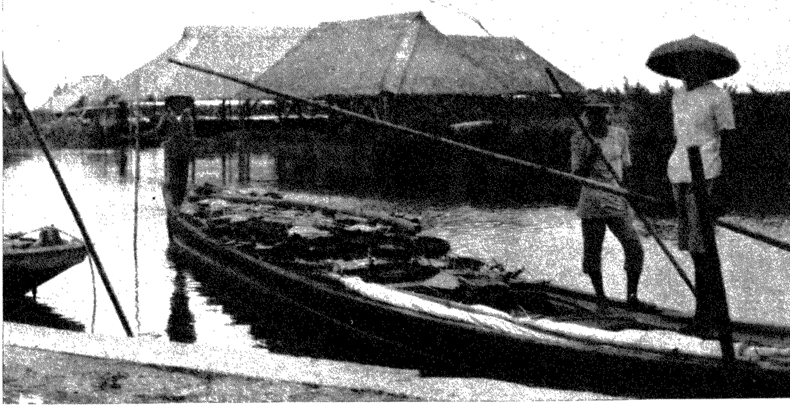

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PLATE 8.

1

2

PLATE 9.

1

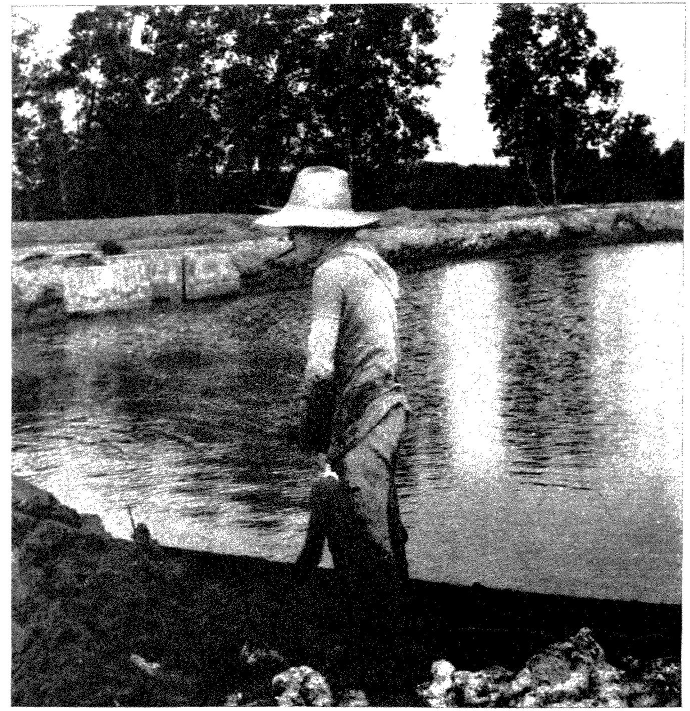

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PLATE 10.

CEPHALOPODS OF THE GENERA SEPIOLOIDEA, SEPIADARIUM, AND IDIOSEPIUS

By S. STILLMAN BERRY
Of Redlands, California

ONE PLATE

Since the manuscript of my "Review of the cephalopod genera Sepioloidea, Sepiadarium, and Idiosepius" (Berry, 1921) left my hands to go to the Australian publishers, an unexpected amount of additional information regarding several of the species belonging to these peculiar genera has been acquired, a digest of which is here offered by way of a needful supplement to the previous paper. In this connection my grateful thanks are due to the late Prof. Madoka Sasaki, of the Hokkaido Imperial University, for generously placing several valuable lots of material at my disposal; to Mr. William F. Clapp, of the Museum of Comparative Zoölogy, for the loan of a series of *Sepiadarium* from Hongkong; and to Dr. Theodor Mortensen, of the Universitetets Zoölogiske Museum at Copenhagen, for kindly supplying information regarding certain of the classical Steenstrupian specimens preserved in the collections of that institution.

Meanwhile attention should be called to several recent publications (cited in full at the end of this paper) that deal to some extent with these little squids, among which those of Grimpe, 1920, and Sasaki, 1923, especially should be noticed. For more complete references to the older literature than are given herein, reference may be made to my former paper above cited.

SEPIOLOIDEA AND SEPIADARIUM

Evidence seems to be increasing (characters of the radula, etc.) that *Sepioloidea* and *Sepiadarium* do not after all possess the close affinity that has been supposed with the members of the family Sepiolidæ, to which superficially they seem so similar, but that the subfamily Sepiadariinæ may require transfer to the Idiosepiidæ or else, as a possible alternative, elevation to the rank of an independent family as Fischer, 1882 (p. 350), once treated them.

SEPIADARIUM KOCHII Steenstrup, 1881.

Sepiadarium kochii STEENSTRUP, K. D. Vid. Selsks. Skr. (6) 1 (1881) 218, 235 [8, 25], pl. 1, figs. 1–10.

Sepiadarium kochii BERRY (pars), Rec. So. Austral. Mus. 1 (1921) 349, 351, 355, chart 10 (mention of *kochii* on p. 358 an error).

Descriptive notes.—The courteous loan from the Museum of Comparative Zoölogy at Harvard College of three of the specimens of this species from Hongkong previously noted (Berry, 1921, p. 353, No. 269) enables me to confirm the observations of Steenstrup in several important particulars and in a few respects somewhat to amplify them, although at the same time a few small discrepancies are to be noted.

One of the principal disagreements is with respect to the relative order of length of the arms, which Steenstrup distinctly states (1881, p. 216) to be of the formula 1, 3, 4, 2, whereas in the Harvard specimens, as is brought out in the accompanying table of measurements, the third pair is always slightly, but distinctly, the longest, and the general arm formula is best written 3, $1 = 2$, 4, or 3, 1, $2 = 4$. This circumstance necessitates a slight correction in the tentative key offered in my former paper (p. 351).

The length of the fins is another variable, the longest fin of the largest female being over half as long as the mantle, thus approaching the condition described for Robson's *auritum.*

The arm suckers of the female are small, with moderate-sized pyriform apertures relatively much more ample than those of the larger corresponding suckers of the male. In two series for the most part (that is, about eighteen pairs on an arm of the third pair), the rows are separated, except at the base of the arm, by a distinct flattened bare area as wide or wider at its broadest part than the suckers themselves. At the extreme tip of the arm the suckers are much reduced and crowded into four rows.

The arm suckers of the male are nearly spherical, relatively larger than in the female and with very small pyriform apertures. Over most of the arm (nine to ten pairs) they are in two series, but at the tip become much reduced and crowded into about four series. The rows are nowhere separated by a median bare area.

The nuptial arm is the left ventral. Here the proximal half of the arm is normal, with some eight pairs of normal suckers. The distal half of the arm is strongly recurved or half-coiled dorsad, its suckers entirely atrophied and their place taken by

what must be interpreted as their highly modified bases, enlarged and coalesced into a series of fleshy, obliquely transverse ridges, about eighteen in number, each divided by a distinct longitudinal furrow along the ridge into two quite distinct elevations. The summit of each of these elevations is drawn out into a sort of papilla, with that on the ventral side in each case the more proximal in position as well as somewhat the larger. A low subangulate ridge parallels the modified area a little way from it, forming here the dorso-oral angle of the arm, but there is no other evidence of a dorsomarginal web. The ventromarginal web is strongly developed as a wide fleshy crenulated vertical membrane a little higher than the transverse ridge over against which it lies, and with which it is connected by stout trabeculæ arising distally from the ventral division of each transverse ridge and passing out between it and the ridge next in front.

TABLE 1—*Measurements of Sepiadarium kochii Steenstrup.*

	Author's register No.		
	269, ♀	269, ♀	269, ♂
	mm.	*mm.*	*mm.*
Total length	38	38	28
Length of body, dorsal	18	16	14
Length of body, ventral	20	14	16
Tip of body to base of dorsal arms	25	21.5	19
Width of fin at widest point	4	3.5	2.5
Length of fin	11.5	7	7
Width across fins	22.5	18	14
Width of body	16	13.5	10.5
Depth of body	14	9	8
Width of head across eyes	13	11	10
Length of head (nuchal commissure to base of dorsal arms)	7	5.5	5
Length of exposed portion of funnel	2	7	1.5
Length of right dorsal arm	10	11	8
Length of left dorsal arm	10	11	8
Length of right second arm	10	12	7.5
Length of left second arm	10	12	7.5
Length of right third arm	11	13	9
Length of left third arm	11	15	9
Length of right ventral arm	9	10.5	8
Length of left ventral arm	+6	10.5	8
Length of right tentacle	14	([a])	13
Length of right tentacle club	4	----------	3
Length of left tentacle	([a])	19	9
Length of left tentacle club	----------	4	3

[a] Mutilated.

The tentacle club has about six (male) to eight (female) indistinct series of very minute suckers and a wide keel.

The mantle margin is sometimes slightly crenulate, but not (in these specimens) digitate near its juncture with the body.

The radula (female) has strongly developed rhachidian teeth with squarish bases and single long, acute central cusps. The first laterals are minute, overhanging, with a short acute median cusp and only the weakest possible hint of side cusps. The second laterals are very broad at the base, which is strongly produced, as though by an accessory cusp, toward the major laterals, the principal cusp about half again as long as the adjoining first lateral, stout, acute, and somewhat attenuated. The major laterals are stout, strongly falcate, somewhat longer than the rhachidians.

Type locality.—At my request Dr. Theodor Mortensen kindly looked up Steenstrup's original material of this species, and writes definitely that, as has been presumed, the type specimen in the Universitetets Zoologiske Museum comes from Hongkong.

Distributional note.—The records of *kochii* from Japanese waters should probably be deleted in toto, as all specimens seen from that region appear to belong to the following distinct species. Some of the Ceylonese and East Indian records would also perhaps bear a critical reëxamination.

SEPIADARIUM NIPPONIANUM sp. nov.

Sepiadarium kochii SASAKI, Zool. Mag. Tokyo (1913) 247, fig. 2 (text in Japanese), not of Steenstrup, 1881.

Sepiadarium kochii SASAKI, Annot. Zool. Japon. 8 (1914) 597.

Sepiadarium kochii BERRY (pars), Rec. So. Austral. Mus. 1 (1929) 351, 352, chart 10 (probably all of the Japanese records).

Sepiadarium kochii M. ISHIKAWA, Journ. Coll. Agr. Im. Univ. Tokyo 7 (1924) (167), 182, pl. 10, fig. 36.

Diagnosis.—Body small, sepioliform, comparatively short and rounded posteriorly. Fins rather small, attached behind the middle; their maximum length 40 to 53 per cent that of the mantle; in outline semicordate, with a fairly strong anterior and weak posterior lobe. Mantle united with head by a nuchal commissure about half as wide as the body; its free margin somewhat emarginate below the funnel and usually showing a slight, foldlike notch on either side of the commissure, though without traces of true crenulation or digitation in the type material.

Head large, about as wide as the body. Eyes large, with the usual crescentic lid folds. Funnel moderately long, reaching two-thirds or more of the distance from the mantle margin to

the cleft between the ventral arms, thick-walled and fleshy, its interior with a small, rounded-triangular, flaplike valve near the apex; funnel organ comprising a large chevron-shaped dorsomedian member and a pair of more or less pyriform ventrolateral pads.

Sessile arms rather short, their order of relative length somewhat variable in preserved specimens, but the third pair quite distinctly the longest and the formula as a whole usually 3, 2, 1, 4, the dorsal and ventral arms being nearly of a length; in some specimens the arms of the second pair are distinctly the shortest. Suckers small, rounded kidney-shaped, with small, projecting, roundish apertures; those on proximal half of arms in two well-separated rows (comprising eight or nine pairs on dorsal arms, nine or ten pairs on remaining arms), the third to seventh or fourth to seventh pairs quite distinctly the largest; on the distal half of the arms suddenly reduced in size and crowded into four rows; two or three basalmost pairs of suckers on all arms distinctly smaller than those succeeding and the apical suckers minute again; the two series of suckers on the proximal part of the arm well separated but showing no conspicuous flattened bare area between, even in the female. Nuptial arm the left ventral; proximal half of arm normal, bearing about eight pairs of normal suckers; distal half somewhat excavated and curved to the left, its suckers replaced by a series of about twenty-four fleshy transverse ridges, evidently formed by coalescence of the thickened bases of the entirely atrophied suckers, each ridge being distinctly bipapillose at the summit, and connected at its ventrodistal angle with the nearly obsolete ventral web by a sort of fleshy trabeculum; toward the tip of the arm the web seems better developed in relation to the ridges but nowhere succeeds in encroaching very much upon them; a subangulate ridge parallels the hectocotylized area a little way from it, forming the dorsal angle of the arm in this region, but there is no dorsal web.

Tentacle rather less robust than the arms and from about half again to nearly twice their length; the club short, strongly keeled, with numerous minute suckers, which on the central portion appear to rank in about eight scarcely defined rows, and seem everywhere nearly uniform with only very gradual gradation in size.

Radula with stout rhachidian teeth having long, acute, somewhat attenuated cusps arising from rectangular bases; first laterals very small and short, with a short, stout major cusp,

which is continued out into a minute accessory cusp on the inner margin; second laterals again much larger, very broad and overhanging, with a single wide, acute cusp; major laterals long and strongly falcate; marginal plates extremely minute, pyriform.

TABLE 2.—*Measurements of Sepiadarium nipponianum sp. nov.*

	Author's register No.			
	724, ♂, type.	725, ♂, paratype.	725, ♀, paratype.	725, ♀, paratype.
	mm.	*mm.*	*mm.*	*mm.*
Total length	32	40+	42	45
Length of body, dorsal	11	16.2	16	15
Length of body, ventral	10	14.5	14	13.5
Tip of body to base of dorsal arms	16	21.7	22	21
Width of fin at widest point	2.5	3.5	3.5	3.5
Length of fin	6.5	6.4	7.6	8
Width across fins	15	18	19	18
Width of body	10.4	13.5	12	11.3
Depth of body	7.6	8.2	10	10
Width of head across eyes	9	11.4	11	11.5
Length of head (nuchal commissure to base of dorsal arms)	5	5.7	6	6
Width of nuchal commissure	5.4	5.5	5	5.5
Length of exposed portion of funnel (median)	4.5	6.6	5	5
Length of right dorsal arm	9.6	16	12.5	11.2
Length of left dorsal arm	9.6	16.7	12.5	11.6
Length of right second arm	10.6	----------	10+	12
Length of left second arm	10.7	13+	13.5	11.5+
Length of right third arm	12	12+	14.3	13
Length of left third arm	12	13	14.5	11+
Length of right ventral arm	9.5	14.7	11.5	10.4
Length of left ventral arm	9	13.6	11.2	12
Length of right tentacle	----------	----------	20	24
Length of right tentacle club	----------	----------	4	4
Length of left tentacle	15	----------	18	23
Length of left tentacle club	2.5	----------	4	4

Type.—A male in the author's collection (S. S. B. 724). A paratype is to be deposited in the South Australian Museum and another has been returned to Prof. Madoka Sasaki (725).

Type locality.—Sagami Bay, Japan; Madoka Sasaki collector, April 10, 1918; 2 males, 6 males.

Recorded distribution.—JAPAN,[1] Sagami Bay!; Enoura, Suruga (*Sasaki*); off Nukumi, Satsuma (*Sasaki*); Beppu, Bungo

[1] I refer here all Japanese records published as *S. kochii.* Were there more than one species of *Sepiadarium* represented in the Japanese collections it would seem as though the numerous keen students of that nationality would have detected them.

(*Sasaki*); Kurihama, Musashi (*Sasaki*); Nagasaki (*Sasaki*); Fukue, Mikawa (*M. Ishikawa*).

Remarks.—In my former paper the suggestion was made that the discrepancies to be noted between the original figures of *S. kochii* Steenstrup and Sasaki's account of his Japanese specimens of *Sepiadarium* are such as to indicate the possibility of more than one species being involved. Since then the friendly contribution by Professor Sasaki of some of his own material has enabled a direct comparison with the specimens of true *kochii* from Hongkong previously noted, with the result that I find my surmise measurably confirmed. Although inconspicuous at first glance the differences observed are reasonably uniform, are in accord with the published observations of Sasaki on his more ample Japanese material, and seem amply sufficient to justify the present separate recognition of the Japanese form. To sum up, *nipponianum* is very close in most characters to *kochii*, but the specimens can be readily separated by the fact that in the females of *kochii* there is a distinct space free of suckers down the middle of the median portion of the arm which is represented in the Japanese species merely by an incipient separation of the rows, and the fact that in the males of *nipponianum* the transverse ridges of the nuptial arm are more conical, more distinctly papillose, more elevated, and more numerous.[2] The relative lengths of the arms are likewise somewhat different, and there are differences in the details of the radula, notably in the shape of the second lateral teeth. No doubt if this interpretation of the facts be well conceived, further characters of import will be brought to light by the examination of more and better material than that now in hand.

Returning to the radula, it may be said that this organ is in general quite like that of *kochii* as would be expected, but there seem to be too many small differences to find their entire explanation in individual variation. The relative stoutness and great width of the second laterals in the present species are probably characteristic, yet it would doubtless be as well to check up these points with more ample material before placing too much reliance upon them. Unless very strongly stained with some such medium as chromic acid the exact form of the teeth is quite difficult to make out in mounted preparations. The radula of *Sepiadarium*, especially in the relative complexity of the first lateral and major lateral teeth, recalls the Loliginidæ

[2] Although it must be admitted that Steenstrup's original figure of *kochii* shows as many.

much more than either the Sepiolidæ (*Rossia, Euprymna,* etc.) or the Sepiidæ, where the dentition is of a much simpler type.

The arm and tentacle complex of this species has already been figured by Sasaki, 1913, fig. 2.

IDIOSEPIUS

Much still remains to be worked out before we can feel certain of the exact natural position and relationships of this small but highly specialized and interesting genus. Grimpe, 1920, referred his segregate *Naefidium* to the Loliginidæ, establishing therein to receive it a new subfamily Naefidiinæ. However, in a postscript to the same paper he later restored it to the Idiosepiidæ. Naef, 1921, places the family without question in his major group Sepioidea. In the phylogenetic tree that has been worked out on the basis of statocyst structure, *Idiosepius* stands rather alone, the adult organ remaining in a somewhat primitive condition.

IDIOSEPIUS PYGMAEUS Steenstrup, 1881.

Idiosepius pygmaeus STEENSTRUP, K. D. Vid. Selsk. Skr. (6) 1 (1881) 219, 236 [9, 26], pl. 1, figs. 11–22.

Idiosepius pygmaeus BERRY, Rec. So. Austral. Mus. 1 (1921) 355, 357, 359, 361, text fig. 64, chart 11.

Dr. Theodor Mortensen, of the Copenhagen Museum, from an examination of the original material has kindly confirmed the type locality of this species as given in my earlier paper; namely, 4° 20′ north latitude, 107° 20′ east longitude.

IDIOSEPIUS PARADOXUS (Ortmann, 1888).

Micreteuthis paradoxa ORTMANN, Zool. Jahrb. Abth. Syst. 3 (1888) 649, 665, pl. 22, fig. 4.

Idiosepius pygmaeus SASAKI, Zool. Mag. Tokyo (1913) 401 (context in Japanese), pl., figs. 3, 4 (not of Steenstrup).

Idiosepius pygmaeus SASAKI, Annot. Zool. Jap. 8 (1914) 599.

Idiosepius pygmaeus SASAKI, Proc. U. S. Nat. Mus. 57 (1920) 191.

Idiosepius paradoxus BERRY, Rec. So. Austral. Mus. 1 (1921) 356, 357, 358, text fig. 65, chart 11.

Idiosepius pygmaeus SASAKI, Annot. Zool. Jap. 10 (1923) 209, text figs. 1–3 (behavior, etc.).

Idiosepius pygmaeus M. ISHIKAWA, Journ. Coll. Agr. Imp. Univ. Tokyo 7 (1924) (167), 179, pl. 10, fig. 33 (statocyst).

Additional distributional records.—JAPAN, surface Hakodate Bay (*Sasaki*); Onomichi, Bingo (*Sasaki*); Isé Province (*Sasaki*); Oki Island (*Sasaki*); Sado Island (*Sasaki*); Oshoro (*Sasaki*); Fuke, Mikawa (*M. Ishikawa*).

Remarks.—This species had been unknown to me from any direct observation with specimens until Professor Sasaki, after

my former paper, had the great kindness to send me a series, comprising two males and two females, collected by himself off Sagami Province, Japan, August 25, 1907 (S. S. B. 723), which entirely confirm my former impression of its distinctness from *pygmaeus*. As the specimens evidently are none of them fully grown (the largest has a mantle length of but 7 millimeters), I shall not dwell upon them at length here. There are a few points of some interest, however, that may be noted.

The larger of the two males shows seven suckers on the left nuptial arm and five on the right. The tentacles of these same specimens bear suckers for but little more than half their length and their unsuckered bases are scarcely as robust as most of the sessile arms, in these particulars showing a further deviation from Sasaki's figures, although not from his descriptions.

Sasaki, 1920 (p. 191), has carried the known range of this species in Japan as far to the north as Hakodate. He once wrote me (in litt. of August 10, 1920) that he had observed the curious habit for *Idiosepius* of adhering dorsally to seaweeds. Since then (1923) he has published a brief but highly important note on this strange behavior as manifested by specimens of *I. paradoxus* maintained under laboratory conditions. Other than this practically nothing is known of the natural history of any of these little squids, which now promises to be of as unique interest as their morphology.

No sexual dimorphism in size has been positively observed for this species so far as I can discover. My two males are, indeed, conspicuously smaller than the females, but this is possibly but an incident of this particular material that would disappear were all the specimens to attain equal maturity. Sasaki's Hakodate specimens have a recorded mantle length of 12 millimeters for the male and 15 millimeters for the female, but here again the specimens seen appear too few to afford certainty that the proportionate dimensions noted are characteristic for the sexes.

IDIOSEPIUS PICTETI (Joubin, 1894).

Loligo picteti JOUBIN, Rev. Suisse Zool. 2 (1894) 26, 60–64, pls. 3, 4.

Idiosepius picteti JOUBIN, Rev. Suisse Zool. 3 (1895) 459–460.

Naefidium picteti GRIMPE, Zool. Anz. 51 (1920) 205, 208–214, text figs. 1B, 2A–B.

Idiosepius picteti BERRY, Rec. So. Austral. Mus. 1 (1921) 356, 357, 359, 361, text fig. 66, chart 11.

Idiosepius picteti NAEF, Mitt. Zool. Stat. Neapel 22 (1921) 541 (brief note).

Remarks.—Grimpe, 1920 (p. 208-214), has gone to some length to separate this species not only from *Loligo,* its independence from which had already been fully recognized by Joubin and others, but from *Idiosepius* as well, regarding it as the representative of a new genus, *Naefidium.* In justification Grimpe advances two considerations; namely, the "long (loliginiform) mantle sack" and the peculiar hectocotylus, although in a postscript, in which he mentions the prior "Note complémentaire" of Joubin, he tacitly admits the essential similarity of the nuptial arm to that of *Idiosepius,* even while still maintaining that "die Validität des neuen Genus *Naefidium* dadurch nicht berührt wird." If his genus did not depend upon the characters of the nuptial arms it is hard, indeed, to discover a present foundation for it except such as may be gleaned from the peculiarities in body form. That the latter are as fundamental as alleged seems to me very doubtful when all known members of the group are brought into purview. Even the original figures given by Steenstrup for *I. pygmaeus* show sharp divergencies in their delineation of the posterior region of the body, the female being shown as obtusely pointed and only the male as smoothly rounded; that is, nearly sepioliform. That such apparent differences may not even be specific we are now aware through the investigation of the far more extreme sexual dimorphism manifested in the Australian *S. notoides,* which will be dwelt upon more at length in a forthcoming monograph on the South Australian cephalopod fauna. One needs concede but little leeway to the reconstruction of the older artists to bring the contours of the female *notoides* close to those of *picteti,* and the contours of male *notoides* to those of *pygmaeus,* the sex differences being fully as great in many particulars as the specific.

It follows that in order to recognize *Naefidium* as valid there must be established some character of import additional to a mere difference of bodily proportions to afford sufficient grounds for the generic separation, and this has not yet been done. While it should be remembered that each of the four described species of *Idiosepius* is so remarkably distinct from any of the others that an eventual dismemberment of the group may, indeed, be the outcome, new discoveries may so alter the whole situation that it is to be doubted whether any true progress is to be attained by striving at an uncertain and premature subdivision now.

DOUBTFUL SPECIES

The following elusory species from the earlier literature have been unsolved enigmas to all later students. They are not all referable to *Idiosepius* with any certainty, and were, therefore, omitted from consideration in my 1921 paper, but for the sake of historical completeness some mention of them in this connection should be made.

IDIOSEPIUS MINIMUS (Férussac, 1830).

Cranchia minima FÉRUSSAC, in d'Orbigny and Férussac, Céph. acét., Cranchies (1830) pl. 1, figs. 4–5 (teste d'Orbigny).

Loligo minima D'ORBIGNY and FÉRUSSAC, Céph. acét., Cranchies (1839) 319.

Loligo minima D'ORBIGNY, Moll. viv. et foss. (1845) 241, 351.

Loligo minima GRAY, Ceph. Brit. Mus. (1849) 75.

Loligo minima TRYON, Man. Conch. (I) 1 (1879) 150, pl. 58, fig. 192 (after d'Orbigny and Férussac).

Cranchia minima STEENSTRUP, K. d. Vid. Selsk. Skr. (6) 1 (1881) 224 [14].

Cranchia minima HOYLE, Rep. Chall. Ceph. (1886) 20, footnote (brief note).

Idiosepius minima [err. typ.] NAÉF, Mitt. Zool. Sta. Neapel, Bd. 22 (1921) 541 (merely listed).

Habitat.—Coast of Africa (*d'Orbigny*).

Remarks.—This hitherto apocryphal species has within recent years been referred by Naef to *Idiosepius*. The original figure and description have never been accessible to me, but a fragmentary copy of Tryon's monograph now in hand fortunately contains the pages dealing with *Loligo minima* and the plate containing the reproduction of Férussac's figure. Reference to these convinces me that Naef is reasonably near a correct generic allocation of the species. Indeed, Steenstrup himself (1881, p. 224) was inclined to a similar view, but the actual species represented is, and perhaps ever must remain, doubtful.

The mantle length is given as 15 millimeters, which is about the recorded maximum of *I. pygmaeus*, but the arms and tentacles are represented as considerably longer than in any of the established species of the genus.

LOLIGOPSIS PERONII Lamarck, 1812.

Loligopsis peronii LAMARCK, Extrait de son Cours de Zool. (1812) 123 (teste d'Orbigny).

Sepia sepiola PERON MS. in Lesueur, Journ. Acad. Nat. Sci. Phila. (1) 2 (1821) 100 (*not* of Linnaeus).

Sepia minima LESUEUR, Journ. Acad. Nat. Sci. Phila. (1821) 100.

Loligo peronii BLAINVILLE, Journ. de Phys. 96 (1823) 124 (teste Hoyle).
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Loligopsis? peronii GRAY, Ceph. Brit. Mus. (1849) 41.
Loligopsis peronii STEENSTRUP, Overs. K. d. Selsk. Forh. (1861) 85 [17].
Loligopsis peronii TRYON, Man. Conch. (1) 1 (1879) 164.
Loligopsis peronii VERRILL, Trans. Conn. Acad. 5 (1881) 301.
Loligopsis peronii VERRILL, Rep. U. S. Comm. Fish and Fisheries 1879 (1882) 335 [125].
Loligopsis peronii ROCHEBRUNE, Bull. Soc. Philamth. Paris (7) 8 (1884) 14 [8].
Loligopsis peronii HOYLE, Proc. Roy. Phys. Soc. Edinb. 8 (1885) 314, 333.
Loligopsis peronii HOYLE, Rep. Chall. Ceph. (1886) 20 footnote, 46.

Habitat.—"Coast of Endrach, in New Holland" (*Lesueur*).

Remarks.—There has been a good deal of controversy, perhaps never possible of definite settlement, as to what Lamarck's *peronii* and therewith the old genus *Loligopsis* itself really are. I do not know whether the original specimen is any longer extant. Certainly the information that has been printed regarding it, as though not scanty enough at best, is strangely lacking in mention of all data of any critical import. Yet there are statements in some places and allusions in others that cause me to wonder whether some animal of our modern group *Idiosepius* was not actually what Lesueur and Lamarck had in hand. In connection with such an hypothesis the following considerations seem conceivably significant, although of course the mere fact that they do not conflict with the suggested interpretation in no wise proves its correctness:

1. The body is stated by d'Orbigny, 1845 (p. 373), to be fleshy (*carnosum*), rather than "gelatinous translucent" as stated by Hoyle, 1885 (p. 315), on the perhaps not too reliable authority of Blainville.
2. The fins are described as semirhomboidal and not rounded.
3. Lesueur, 1821 (p. 100), says that his *minima*, from "the coast of Endrach, in New Holland", differs from *sepiola* Linn., although from the very circumstance of Peron's name it was evidently considered sepioloid in form. He adds that it is "very small."
4. The mantle is described as "subacute at the base and finned inferiorly."

5. Coming from Australian waters the specimen falls within the probable range of *Idiosepius*.

Weighing contra are the following points:

1. The apparently deciduous tentacles (not readily lost by animals of the genus *Idiosepius*).

2. The alleged oceanic habit (Verrill, 1882, p. 335).

3. The fact that Blainville described the consistency of the body as gelatinous.

4. It is probably not certain that all the authors cited had the same animal in mind.

It is of interest to note that here again some such possibility as that suggested appears to have been considered by the indefatigable Steenstrup, even though if possible of proof his own genus *Idiosepius* would thereby be invalidated.

As matters stand the question remains about as far from satisfactory settlement as ever.

LOLIGOPSIS CHRYSOPHTALMOS (Tilesius).

Sepia chrysophtalmos TILESIUS, Krusenstern Voy. Atlas, pl. 38, figs. 32, 33 (teste d'Orbigny).

Loligopsis tilesii FÉRUSSAC, In d'Orbigny and Férussac, Céph. acét., Calmars (1825) pl. 1, figs. 2–4 (teste d'Orbigny).

Loligopsis chrysophtalmos D'ORBIGNY, Moll. viv. et foss. (1845) 304, 373, 374.

Loligopsis chromorpha D'ORBIGNY, Moll. viv. et foss. (1849) 373.

Loligopsis chromophora D'ORBIGNY, Moll. viv. et foss. (1845) 374.

Loligopsis ?chrysophtalmos GRAY, Ceph. Brit. Mus. (1849) 42.

Sepia chrysophthalmos STEENSTRUP, Overs. K. d. vid. Selsk. Forh. (1861) 86 [18] (brief note).

Loligopsis chrysopthalmos TRYON, Man. Conch. (1) 1 (1879) 164, pl. 69, fig. 256 (after d'Orbigny and Férussac).

Loligopsis chrysophthalma VERRILL, Trans. Coon. Acad. 5 (1881) 301.

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Loligopsis chrysophtalmos HOYLE, Proc. Roy. Phys. Soc. Edib. 8 (1885) 330, 333.

Sepia chrysophthalmos APPELLOF, Bergens Mus. Aarsb. 1890 (1891) 25 (brief note).

Habitat.—Japan (*Tilesius*).

Remarks.—Steenstrup, 1861, considered that the crude illustrations published indicated that this very doubtful species had affinities with *Rossia* or some related genus. This was subsequently doubted by Appellof, 1891, on the ground that we have no justifiable reason to go back of the characters shown in Ti-

lesius's figures. I have seen only the figure in Tryon's Manual, which shows but seven arms as against the eight called for in the description and gives the observer little confidence that it is less faulty in other particulars. There is evident danger in too meticulously following so patently inaccurate a sketch. Granting a little necessary leeway in this direction, it does not require great imaginative powers to suggest the possibility that an *Idiosepius*, perhaps indeed even Ortmann's *paradoxus*, was really the animal intended to be described. Certainly the figure, such as it is, bears resemblance to an *Idiosepius* done in caricature, and the following additional points further favor the hypothesis:

1. The minute size—hardly an inch long ("a peine longue d'un pouce," according to d'Orbigny).
2. The subterminal separate fins.
3. The obvious sepioliform aspect.
4. The Japanese origin of the specimens, where
5. the species is said *to live on the fucus* (d'Orbigny, 1845, p. 373).

In the light of the recent remarkable observations of Sasaki (1923) that *I. paradoxus* has the peculiar habit of adhering to seaweeds, it seems to me that this last point, long overlooked as insignificant, at once becomes both suggestive and important, though doubtless still short of the virtual proof we should require before rejecting Ortmann's well-known name for the obscure if ancient one of Tilesius.

ERRATA

Owing to certain contingencies of publication of my 1921 paper no opportunity was afforded for proof reading by the author, and the paper consequently contains a number of typographical errors, some of the more troublesome of which, other than a number of misspellings in citation, are as follows:

Page 351, line 15, *for* with figs. *read* and ff. *or* et seq.
Page 352, line 3, for *kochil* read *kochii*.
Page 355, line 28, *for* with figs. *read* and ff. *or* et seq.
Page 356, line 31, *for* text fig. 2 *read* chart 11.
Page 358, line 27, for *kochii* read *pygmaeus*.
Page 360, line 6, for *paradoxa* read *paradoxus*.

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[3] Titles already cited in full in 1921 are not reprinted on this occasion, the present list of references being merely additional thereto.

ILLUSTRATIONS

PLATE 1

FIG. 1. *Sepiadarium kochii* Steenstrup, female [269]. Radula of specimen from Hongkong; part camera drawing from mount in balsam; teeth shown from same general region of radula, but not all from exactly the same transverse series.

2. *Sepiadarium nipponianum* sp. nov. male [724]. Left ventral arm of type in oral aspect; × 9. On account of the abrasion of most of the suckers from the original specimen, these have been uniformly supplied in the drawing except the distalmost pair. Rodman K. Cross del.

3. *Sepiadarium nipponianum* sp. nov., male [724]. Detail of left ventral arm in oral aspect; × 21; the suckers treated as in fig. 2. Rodman K. Cross del.

4. *Sepiadarium nipponianum* sp. nov., female [725]. Sucker of left tentacle club of paratype; camera sketch from mount in balsam.

5. *Sepiadarium nipponianum* sp. nov., female [725]. Radula of paratype; camera sketch from mount in balsam.

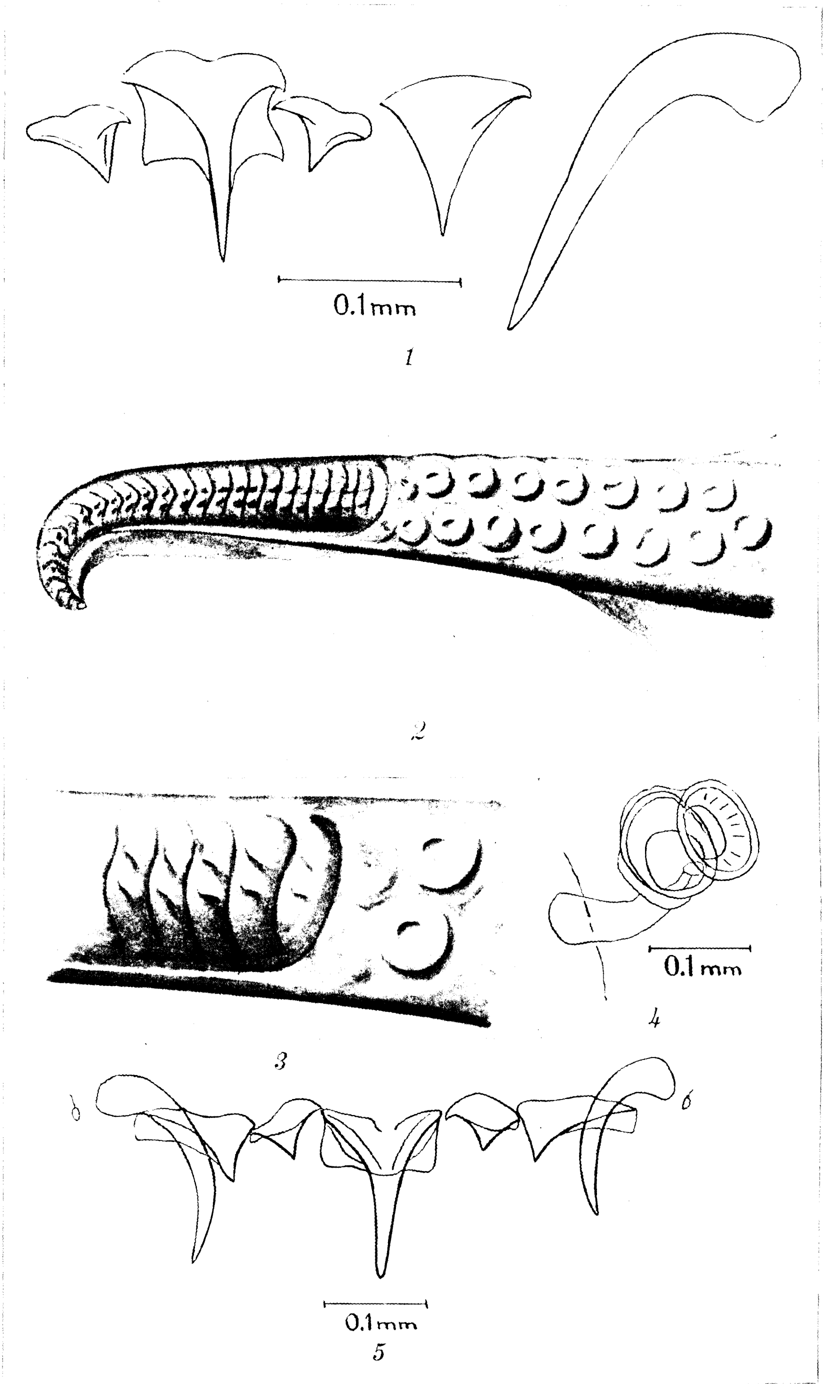

PLATE 1.

PHILIPPINE ERICACEÆ, III: A TAXONOMIC REVISION

CONCLUDED

By HERBERT F. COPELAND

Of Sacramento Junior College, Sacramento, California

EIGHT PLATES

Genus GAULTHERIA Linnæus

The type of *Gaultheria* is *G. procumbens* Linn., a plant of eastern Canada and the northeastern United States. About one hundred thirty species are recognized; of these about two-thirds belong to the American continents, North and South; about half a dozen are described from New Zealand and Tasmania; one from Australia; and about twenty from the continent of Asia. Fourteen species are at present recognized as inhabiting the Malay region; these may be arranged in three series, distinguished as follows:

1. Leaves generally under 2 cm long................ Allies of *G. nummularioides*.
1. Leaves generally over 2 cm long.
   2. Leaves elliptic, conspicuously punctate beneath. Allies of *G. fragrantissima*.
   2. Leaves ovate or lanceolate, usually acuminate, not conspicuously punctate beneath .... Allies of *G. leucocarpa*.

ALLIES OF GAULTHERIA NUMMULARIOIDES

Gaultheria nummularioides D. Don was described in 1824 as occurring in India. *Gaultheria repens* Blume (1826), described from the Gedé, Java, is generally regarded as a synonym of *G. nummularioides*. The latter has been reported from Sumatra, as collected by Forbes and Robinson and Kloss, but not from the Malay Peninsula, nor from Borneo, Celebes, and eastward. If, as seems probable from the distribution, the Malayan form can be separated from the Indian, Blume's name is to be restored; it antedates by two years *Gaultheria repens* Rafinesque, a synonym of *G. procumbens*.

Gaultheria borneensis Stapf is known by two collections, both made on Mount Kinabalu at about 4,000 meters. In 1896, Rendle identified as *G. borneensis* a plant collected by Whitehead in northern Luzon. Merrill, on first collecting the same plant in

1905, regarded it as a new species and prepared a description; but presently concluded that Rendle had been correct, and left his description unpublished. In 1923, he reduced the Formosan *G. itoana* Hayata to *G. borneensis*. The Luzon plant is here described as a new species. I cannot at this time distinguish the Formosan from the Bornean species, but their geographical separation leads me to expect that this will be found possible.

Other species belonging to this group are the New Guinean *G. novaguineensis* J. J. Smith and *G. mundula* F. v. M.; the latter appears, from the original description, to be one of a very small number of species, definitely belonging to *Gaultheria*, but lacking the forked appendage on each anther cell. Non-Malayan species belonging to this group are *G. itoana*, already mentioned; *G. antipoda* Forst., which, with several varieties or related species, inhabits New Zealand, Tasmania, and Victoria; and the Indian *G. trichophylla* Royle.

The following is offered as a key to the Malayan species:

1. Anthers not four-horned at the summit; ovary glabrous........ *G. mundula*.
1. Each anther, as in most *Gaultheriae*, four-horned at the summit.
   2. Flowers always axillary, always with a definite pair of bracteoles immediately below the calyx; ovary glabrous.... *G. nummularioides*.
   2. Flowers usually in short terminal racemes, sometimes axillary toward the ends of the branches.
      3. Ovary glabrous.
         4. Bracteoles always paired and apical on the pedicel; horns on the anthers erect, about 0.5 mm long............ *G. novaguineensis*.
         4. Bracteoles usually distributed along the pedicel; horns on the anthers recurved, about 1 mm long........................ *G. borneensis*.
      3. Ovary and branchlets pubescent; otherwise like *G. borneensis*. *G. benguetensis*.

1. **GAULTHERIA BENGUETENSIS** sp. nov. Plate 1, figs. 4 and 5.

Gaultheria borneensis RENDLE in Journ. of Bot. 34 (1896) 355; MERRILL in Philip. Journ. Sci. 3 (1908) Bot. 378, Enum. Philip. Fl. Pl. 3 (1923) 246.

Fruticulus humilis; rhizoma gracile ramosum; virgae erectae interdum ramosae, usque ad 20 cm altae, saepius breviores; caules graciles in juventate hirtelli; folia alterna, breviter petiolata, 1–2 cm longa, 3–5 mm lata, anguste elliptica vel oblanceolata, basi cuneata, apice obtusa vel acuta, margine serrata, dentibus in utroque margine c. 3–9, dente quoque glandulam solitariam capitatam ferente, supra glabra, subtus parce capitato-glandulosa, venis pinnatis adscendentibus manifestis paucis; flores terminales, interdum solitarii in pedunculis hirtellis c. 1 cm longis bracteas plures lanceolatas acuminatas ciliatas

ferentibus, interdum 2–4 in racemo, pedicellis ex axillis bractearum proximalium pedunculi c. 5 mm longis, hirtellis, apice glandulas capitatas plures, submedie bracteas 2-3, ferentibus; calyx glaber, obconicus, 2.5 mm longus, lobis 5 triangularibus obtusis c. 1.5 mm longis apice minutissime ciliatis; corolla urceolata, c. 5 mm longa, alba vel rosea, lobis 5 minutis recurvis; stamina 10, filamentis c. 2 mm longis, applanatis, minutissime verrucosis, basi dilatatis; antheris c. 1.5 mm longis, parte distale cuiusque in tubulos duos divisa, tubulo quoque cornua duo c. 0.8 mm longa ferente; discus nullus vel obscurus; ovarium pubescens 1.5 mm altum; stylus teres glaber 3 mm longus; calyx fructiferus carnosus c. 5 mm latus, albus, capsulam loculicidam includens; semina numerosa fusca c. 0.5 mm longa, minutissime fovosa.

LUZON, Mountain Province, Benguet Subprovince, *Loher 3755* (*M*); Pauai to Baguio, *Merrill 4796* (M, W, type); Pauai, *Bur. Sci. 4283 Mearns* (M), *Bur. Sci. 4286 Mearns* (M, W), *For. Bur. 14438 Darling* (M), *Bur. Sci. 8421 McGregor* (M, W), *Merrill 710* (M, W), *Clemens 9206* (M), *Clemens s. n.* (M), *Bur. Sci. 31839 Santos* (M, W, C); Mount Pulog, *Bur. Sci. 44977 Ramos and Edaño* (M, C): Lepanto Subprovince, *Bur. Sci. 5955 Ramos* (M); Mount Data, *Clemens 16393* (C), *Clemens 18778* (C).

Known from a narrowly limited region in the central part of the Mountain Province, at altitudes from about 1,800 to 3,000 meters. Differs from *G. borneensis* and *G. itoana* by the pubescent branchlets and ovary.

ALLIES OF GAULTHERIA FRAGRANTISSIMA

A second species described by Blume, G. *punctata*, has been reduced to *G. fragrantissima* Wallich, but was distinguished as a variety of the same species by J. J. Smith. *Gaultheria fragrantissima* was described from India, and has been reported from the Malay Peninsula and from Sumatra, with a variety *papuana* J. J. Smith in New Guinea. Neither *G. fragrantissima* nor any close relative is known from the Philippines. I do not know the relationships of this species; it is at least not a member of the natural group discussed under the following heading.

ALLIES OF GAULTHERIA LEUCOCARPA

Gaultheria leucocarpa Blume was first collected in Java "in sylvis alterioribus." It has been reported from Sumatra and from the Malay Peninsula, with a variety *papuana* Beccari in

New Guinea, and Merrill has identified a specimen from French Indo-China as belonging here; these records from outside of Java are probably in error. *Gaultheria cumingiana* Vidal, from Luzon, is a closely related species. Other species which have been distinguished in this group are *G. crenulata* Kurz; *G. intermedia*, *G. celebica*, and *G. pullei*, all by J. J. Smith; *G. calyculata* Wernham; and *G. hirta* Ridley. One more species is described below; this is the only segregate from *G. cumingiana* or *G. leucocarpa* that I can base on Philippine material. I am convinced that other species will have to be segregated on the basis of extra-Philippine material; but this is not the place, nor have I material, for satisfactory descriptions. The following is a tentative classification of the group:

1. Corolla glabrous.
 2. Ovary pubescent.
  3. Horns on the anther tubes less than 0.1 mm long; leaves to 12 cm long; rhachides and the very short pedicels pubescent: A race in French Indo-China, represented by *Petelot 3.116.*
  3. Horns on the anther tubes about 0.3 mm long.
   4. Sepals more than half as long as the corolla, spreading: *G. pullei* and *G. calyculata.* These New Guinean species are perhaps not distinct, and may include *G. leucocarpa* variety *papuana* Beccari.
   4. Sepals less than half as long as the corolla, appressed.
    5. Leaves about 6 to 9 cm long, on well-developed petioles.
     6. Flowers in simple racemes; sepals glabrous within; fruit white: *G. leucocarpa*, probably confined to Java.
     6. Racemes sometimes branched; sepals pubescent within: *G. intermedia*, described from three specimens collected by Junghuhn, probably all from the same plant, locality (Java or Sumatra) uncertain.
    5. Leaves about 4 cm long, subsessile: *G. celebica*, known by a single collection.
  3. Horns on the anthers about 0.5 mm long; fruit black.
   4. Racemes generally over 5 cm long, with 8 to 10 or more flowers, rhachises sometimes pubescent: *G. crenulata* Kurz,[1] in Yunnan, Kwangtung, Sumatra, and probably the Malay Peninsula.
   4. Racemes glabrous, mostly under 5 cm long, with 3 to 6 flowers: *G. cumingiana*, in Luzon only.
 2. Ovary glabrous.
  3. Margins of the filaments glabrous: A race in Formosa.
  3. Margins of the filaments bearing a few hairs: A race in the southern Philippine Islands, *G. psilocarpa.*
1. Corolla pubescent: *G. hirta*, in Perak.

[1] *G. leucocarpa* Auct., non Bl; *G. cumingiana* Merrill in Lingnaam Agr. Rev. 4 (1927) 132, non Vidal.

2. GAULTHERIA CUMINGIANA Vidal. Plate 1, fig. 2.

Gaultheria cumingiana VIDAL, Phan. Cuming. Philip. (1885) 184, Rev. Pl. Vasc. Filip. (1886) 170; MERRILL in Philip. Journ. Sci. 3 (1908) Bot. 378, Enum. Philip. Fl. Pl. 3 (1923) 246.

The original description, in Vidal's Phanerogamae Cumingianae Philippinarum, reads:

Fructiculus ramis teretibus interdum sinuosis, glabris vel piloso-setosis. Petioli sub-nulli incrassati. Folia e basi rotundata vel sub-cordata, ovata vel lanceolato-ovata, longe obtuso-acuminata, apice saepissime calloso, longa 2–5 cm. lata 1–2 cm., prope basim lata, inaequaliter spinuloso-serrata vel calloso-serrata, glabra vel praesertim subtus ad nervos adsperse setosa, saepissime ciliata. Alabastra globosa. Flores parvi, 3–5 mm., in racemis axillaribus; bracteae ciliatae, bracteolae ad apicem pedicellorum. Calycis segmenta ovata, triangulares, mucronata, ciliolata. Corolla ovato-campanulata, lobis rotundatis saepissime reflexis. Antherarum loculi apice biaristati. Capsula globosa, 4–7 mm, diam.; calyce succulento, nigro-caeruleo inclusa. Semina numerosa, angulato-cuneata, texta nitida, rufescente.

Cum. 932 Prov. Albay.—Herb. prop. 818 Volcan Mayon, Prov. Albay; 1829 Distr. Lepanto.

LUZON, Albay Province, Mount Mayon, *Bur. Sci. 2923 Mearns* (M), *Bur. Sci. 6500 Robinson* (M): Laguna Province, Mount Banahao, *Loher 6200* (W), *For. Bur. 7896 Curran and Merritt* (M), *For. Bur. 8009 Curran and Merritt* (M), *Bur. Sci. 9846 Robinson* (M); Mount San Cristobal, *Gates 6375* (M): Zambales Province, Mount Pinatubo, *Clemens 17472* (C): Mountain Province, Benguet Subprovince, *Loher 3783* (W); Mount Santo Tomas, *Elmer 6253* (M, W), *Williams 951* (M, W), *For. Bur. 4958 Curran* (M), *For. Bur. 14170 Merritt* (M, W), *Sandkuhl 330* (M), *Merrill 11735* (M, W, C), *McClure 16050* (C); Baguio, *Elmer 8589* (W), *Sevrens 21* (M); Baguio to Ambuklao, *Merrill 4376* (M, W); Pauai, *Bur. Sci. 4277 Mearns* (M), *For. Bur. 14444 Darling* (M), *Bur. Sci. 8417 McGregor* (M), *Clemens 9190* (M), *Clemens s. n.* (M), *Bur. Sci 31785 Santos* (M, C); Pauai to Mount Data, *Clemens 16392* (C); Bugias, *Merrill 4672* (M, W); Batan, *Bur. Sci. 5891 Ramos* (M); Bucao, *For. Bur. 14424 Darling* (M): Lepanto Subprovince, trail to Balbalasan, *For. Bur. 5698 Klemme* (M): Bontoc Subprovince, *Vanoverbergh 748* (M): Ifugao Subprovince, Mount Polis, *Bur. Sci. 37619 Ramos and Edaño* (M).

At altitudes from about 1,500 (Baguio) to about 2,500 meters (Mount Santo Tomas; Pauai).

A rather variable plant; in height from less than 30 cm to more than 2 m; prostrate, erect or scandent. The stems of

some plants bear a fine pubescence mixed with large bristles, while those of others are strictly glabrous; pubescence and bristliness appear to be juvenile characters. The leaves are about 2 to 7 cm long, ovate or lanceolate, acuminate, sharply serrate, the teeth about 1 to 3 mm apart. The glabrous rhachises, 1 to 5 cm long, bear rather few (3 to 6) flowers on glabrous pedicels 2 to 9 mm long. Each pedicel is subtended by a minute ciliate bract and bears a pair of minute ciliate bracteoles, like those of a *Diplycosia,* below the calyx. The calyx is glabrous, cup-shaped, divided to below the middle into five acuminate ciliate lobes. The corolla is campanulate, 3 to 6 mm long, with 5 blunt recurved lobes about 1.5 mm long. The filaments are about 2 mm long (below the anther), flat, distinctly lanceolate, warty but not pubescent, merging into the backs of the anthers. The anthers are about 4 mm long; each anther cell is narrowed above into a forked tube about 1.5 mm long, and opens by a slit down the introrse face of the tube. The whole stamen reaches to about the base of the corolla lobes. The densely pubescent ovary is surrounded at the base by a lobed disk about 0.3 mm high. The terete glabrous style is 2 to 4 mm long. The fleshy fruiting calyx is always black (or blue- or purple-black). The fruit proper dehisces loculicidally, the distal portion splitting into five acute valves that may project slightly from the calyx. The very numerous subtetrahedral seeds are brown, with a surface describable as pitted, or conversely as reticulately ridged.

3. **GAULTHERIA PSILOCARPA** sp. nov. Plate 1, fig. 3.

Gaultheria cumingiana MERRILL in Philip. Journ. Sci. 2 (1907) 292; ELMER in Leafl. Philip. Bot. 3 (1911) 1091; non Vidal.

Species G. cumingianae et G. leucocarpae affinis, ovario glabro, filamentis capillos paucos ferentibus, distincta; calyx fructiferus niger.

Fruticulus terrestris (an semper ?), erectus, procumbens, vel subscandens; caulis saepius sinuosus, glaber vel in juventate hirtellus setosusque; folia alterna in petiolis teretibus 3–8 mm longis, laminis glabris, ovatis vel lanceolatis, 2–9 cm longis, 1–5 cm latis, basi rotundatis, apice acuminatis, margine inaequaliter serrulatis, dentibus glanduloso-vel setoso-apiculatis, inter se in foliis maioribus c. 3 mm distantibus, venatione manifesto; flores in racemis axillaribus, rhachidibus 2–6 cm longis, glabris, flores 2–9 ferentibus; pedicellis glabris 3–9 mm longis, apice bibracteolatis, bracteolis c. 1.5 mm longis, ovatis, acuminatis, glabris

marginibus ciliatis exceptis; calyx c. 2 mm altus, glaber, lobis 5 acuminatis ciliatis; corolla alba campanulata glabra, c. 4 mm longa, lobis 5, c. 1.5 mm longis, obtusis; stamina 10, filamentis applanatis lanceolatis c. 1 mm longis, margine papillosis, capillos paucos albos vix 0.5 mm longos ferentibus, anthers c. 2 mm longis, apice in tubulos duos attenuatis, tubulo quoque in cornua duo c. 0.5 mm longa diviso, per rimam introrsam dehiscente; ovarium globosum glabrum c. 1.5 mm longum; stylus teres glaber c. 2 mm longus; calyx fructiferus carnosus, niger, c. 6 mm latus, capsulam loculicidam includens; semina fusca subtetranedra foveolata c. 0.5 mm longa.

MINDORO, Mount Halcon, *Merrill 5725* (M, W). NEGROS, Canlaon Volcano, *Merrill 235* (M, W). MINDANAO, Bukidnon Province, Mount Candoon, *Bur. Sci. 38903 Ramos and Edaño* (M; type): Davao Province, Mount Calelan, *Elmer 11678* (W).

At altitudes from 1,800 (Mount Candoon) to 2,800 meters (Mount Calelan).

This species varies as *G. cumingiana* does, in stature, leaf size, and pubescence; it usually has larger leaves than *G. cumingiana*, and is readily distinguished, even in fruit, by the glabrous ovary. Flowers are known only by the collection from Mount Candoon, which is designated as the type; the constancy of the scattered hairs on the margins of the filaments is accordingly uncertain.

Genus DIPLYCOSIA Blume

Blume,[2] in describing his genus *Diplycosia*, assigned to it three Javan species. No more were known to G. Don,[3] who misspelled the name as *Diplecosia*, or to de Candolle.[4] The generic status of the poorly known group was long in doubt. Endlicher[5] included the group (without naming the species) under *Gaultheria*, as a subgeneric group called *?Amphicalyx*, a name which Blume[6] had proposed to substitute for his earlier one. The new combinations were made by Hasskarl,[7] who was followed by Zollinger[8] and by Miquel[9]; and Gray[10] described the first *Di-*

[2] Bijdr. (1826) 857.
[3] Gen. Syst. 3 (1834) 838.
[4] Prodr. 7 (1839) 591.
[5] Gen. Pl. (1836–1841) 756.
[6] Flora Javae (1828) introd. 7.
[7] Cat. Pl. Bog. (1844) 160. The names are ascribed to Endlicher.
[8] Syst. Verz. (1854–1855) 135. I have not seen this work, to which Miquel refers.
[9] Ann. Mus. Bot. Lugd. Bat. 1 (1863) 40–41.
[10] Proc. Am. Acad. Sc. 5 (1861) 324.

plycosia known from the Philippines as a *Gaultheria*. The last student of the group who rejected *Diplycosia* as a genus was F. von Mueller,[11] who, in describing *Gaultheria mundula*, argued strongly that the two genera cannot be distinguished.

Other authors have maintained the genus without understanding it, and have transferred to it any gaultherioid species which seemed not to fit into other genera. Bentham and Hooker [12] took note of "Species 7, montium Malaccae Javae et Borneo incolae." The four species added to those of Blume were not named: they were apparently in part undescribed, and in part species named under other genera; some of them probably do not belong to *Diplycosia*. At any event, Clarke [13] transferred to *Diplycosia*, *Gaultheria discolor* Nutt., a species from Bhutan, and described a new *D. semiinfera* from the same region. These authors, and following them Drude [14] defined the genus vaguely and inaccurately. Schlechter—probably without due study, since his conception of the genus was correct—transferred *G. mundula* F. v. M.; and Nakai [15] transferred *G. adenothrix* Maximowicz, a Japanese species. The four species last named have the flowers in racemes, and are to be excluded.

The first satisfactory statement, aside from those drawn directly from Blume's original description, of the essential characters of the genus, seems to have been made by Schlechter,[16] who wrote, "Ich möchte als ihr nicht angehörig alle diejenigen Arten betrachten, die eine traubige Infloreszenz haben, ferner die, welche sich durch das Fehlen der sehr charakteristischen Brakteen unterhalb der Blüte auszeichnen." If to the long-known character that the tube or appendage on each anther sac is not forked, we add the characters emphasized by Schlechter (the axillary production of flowers solitary or in fascicles, never in racemes, and the presence of two connate bracteoles just below the calyx), as well as a character emphasized by Blume, that the fruit proper is a thin-walled capsule which is indehiscent or shatters irregularly, we fully define and distinguish from other *Arbutoideæ* a natural genus inhabiting the Malay Region, mostly at rather high altitudes, and not extending

[11] Trans. Roy Soc. Vict. n. Vict. n. s. 1:2 (1889) 21.
[12] Gen. Pl. 2:2 (1876) 583.
[13] In Hook. f. Fl. Brit. Ind. 3 (1882) 495.
[14] In Engler und Prantl. Nat. Pflanzenfam. 4:1 (1891) 46.
[15] Bot. Mag. Tokyo 35 (1921) 135.
[16] Englers Bot. Jahrb. 55 (1918) 162.

outside of that region. *Diplycosia pilosa,* which Blume listed first is to be accepted as the type.

The first large addition of valid species was made by Beccari,[17] who described seven species from the Arfak Mountains in Dutch New Guinea, from Amboina, and from Sarawak. Another was made by Stapf,[18] who described ten new species from Mount Kinabalu. Since 1894, the gradual progress of exploration in New Guinea, in the Malay Peninsula, and in the Philippines, has added many more. Altogether a total of fifty-two species have been assigned to the genus; but this number is to be decreased to about forty, by the exclusion of some, as mentioned above, and by the reduction of five in the present paper.

The subgeneric classification is difficult. Bentham and Hooker described two subgenera, distinguished by the habit; their classification is to be rejected, because *D. pilosa,* the type, was included in *Gaultheriopsis* instead of in *Eudiplycosia* and because the remaining species of the former subgenus were not enumerated, and were in all likelihood in part not *Diplycosiæ* at all. Natural classification involves the working out of lines of descent. The hypotheses are offered, that *Diplycosia* is descended from *Gaultheria;* that the original *Diplycosia* was a plant of India or of the Malay Peninsula (perhaps of Borneo, since that island, with but poor exploration, shows a great number of species); and that it was an erect plant, with bristly leaves of moderate size, the stem bristly, the flowers numerous in fascicles or perhaps in short racemes, the pedicels and calyces bristly, the anthers drawn out into long tubes opening by introrse slits, the pistil pubescent. The known species would be derived from such an ancestor by the loss of pubescence from different parts independently, by the shortening of the tubes on the anthers, and by changes in habit and in the size and shape of the leaves. Species very similar to one another may have arisen by different lines of descent, and it would require careful study to avoid an artificial classification. The species are not well enough known to warrant attempting such a classification; as for descriptions, Blume and Beccari describe almost nothing beyond the vegetative characters of the species; and as for specimens, these are in this genus very frequently unsatisfactory, since the small flowers and fruits become disjointed between the bracteoles and the calyx, and are lost.

[17] Malesia 1 (1877) 210–212.

[18] Trans. Linn. Soc. Bot. 4 (1894) 191–195.

Thirteen species have been described from the Philippines. Among these, *D. loheri* Merrill, described in 1925, and known by a single collection from the Caraballo Mountains, is well distinguished by the bristly calyx; while *D. trinervia* Elmer, to which *D. urdanetensis* Elmer is here reduced, and which is known by two collections from Mindanao, is distinguished by elongate anthers.

As for the remaining species, the flowers of all, so far as they are known, are essentially alike; the specific differences lie in the size, shape, and surface of the leaves, and in the number per cluster, length, and surface of the pedicels. It is possible that there may be a difference in the fruiting calyces, which appear in some specimens completely to inclose the capsules, and in others to subtend them; but I am not certain that this is more than a difference in stage of development.

There are only two localities from which collections have been made in such numbers that the extent of variation to be expected in a given race can be estimated. One of these, fortunately, is Mount Banahao, the type locality of *Diplycosia luzonica* Merrill. This was described by Gray, under *Gaultheria,* in 1861, from the collections of the United States Exploring Expedition under Captain Wilkes; it was the only Philippine *Diplycosia* described before the American occupation of the Islands. Gray's description was very brief. It is significant of the difficulty of working with *Diplycosia* that the flowers were not collected at the easily accessible type locality until 1918. The leaves are quite setose when young, but become denudate with age. Merrill, who happened at first to know the topotypic race only by a single denudate leaf from the type specimen, took the essentially glabrous race on Mount Santo Tomas as typical of *D. luzonica,* and described as species two races distinct from that, *D. scandens,* from the Mountain Province, in 1906, and *D. merrittii,* from Mount Halcon, in 1907. The variability shown by our present series of specimens from Mount Banahao leads to the reduction to *D. luzonica* of both *D. scandens* (which Merrill reduced in 1908, and restored in 1923) and *D. merrittii,* and also, less certainly, of *D. fasciculiflora,* a small-leaved plant from the Mountain Province, described in 1915.

The race on Mount Santo Tomas is also known by several collections. It appears to vary so as to overlap *D. calelanensis* Elmer, a species described in 1911 as occurring on Mount Apo, to which the Santo Tomas race is accordingly referred. It appears at the same time to overlap *D. glabra* Merrill, described

in 1919 as inhabiting the Mountain Province, and here reduced to *D. calelanensis*.

Beside the four species already mentioned, four more are here maintained, two described by Elmer, one by Merrill, and one by C. B. Robinson; these are maintained more by ignorance than by recognition of distinctive characters. None is known by more than one collection from any locality, nor from more than two localities; and of none have I seen mature flowers (those of *D. apoensis* and *D. baclayanensis* are known by Elmer's descriptions; those of *D. opaca* were described from buds; those of *D. parvifolia* are unknown).

Key to the Philippine species.

1. Calyx beset with large bristles........ 1. *D. loheri*.
1. Calyx glabrous or puberulent, not bristly.
   2. Flowers three or more in the cluster, or if not, leaves over 3 cm long.
      3. Anthers linear, about 3 mm long........ 2. *D. trinervia*.
      3. Anthers oblong, not over 2 mm long.
         4. Pedicels usually densely bristly; leaves bristly at least when young, 1 to 9.5 cm long........ 3. *D. luzonica*.
         4. Pedicels sparsely or not at all bristly; leaves glabrous.
            5. Leaves not thickly coriaceous.
               6. Leaves 3 to 6 cm long, obtuse or acute........ 4. *D. calelanensis*.
               6. Leaves 4 to 8.5 cm long, mostly rounded........ 5. *D. opaca*.
            5. Leaves thickly coriaceous, 6 to 7 cm long.... 6. *D. baclayanensis*.
   2. Flowers solitary or in pairs; leaves not over 3 cm long.
      3. Leaves 3-nerved........ 7. *D. apoensis*.
      3. Nerves, except the midrib, obsolete........ 8. *D. parvifolia*.

1. **DIPLYCOSIA LOHERI Merrill. Plate 1, figs. 6 and 7.**

Diplycosia loheri MERRILL in Philip. Journ. Sci. 27 (1925) 44, Enum. Philip. Fl. Pl. 4 (1925) 253.

The original description reads:

Frutex ut videtur scandens, ramulis et pedicellis et calycis perspicue patule ciliato-setosis; foliis elliptico-ovatis, subcoriaceis, obscurrisime nervosis, 2.5 ad 4 cm longis, acuminatis, basi obtusis ad subrotundatis, utrinque margineque parce setosociliatis; floribus axillaribus, solitariis vel binis, rariter trinis, tenuiter pedicellatis, pedicellis 1 ad 2.5 cm longis; corolla turbinata, glabra, 5.5 mm longa, lobis late ovatis, reflexis, 1.5 mm longis; filamentis glabris, 2 ad 2.5 mm longis, antheris circiter 1.4 mm longis, apice breviter productis.

A shrub, apparently scandent, the branchlets, pedicels, and calyces conspicuously ciliate-setose with numerous, reddish brown, spreading hairs 0.5 to 3 mm long, similar but more-scattered hairs on both surfaces of the leaves and on their margins. Branches glabrous, dark when dry, the branchlets paler, the ultimate ones 1 to 1.5 mm in diameter. Leaves subcoriaceous, elliptic-ovate, somewhat acuminate, base obtuse to rounded,

olivaceous on the upper surface when dry, paler beneath, 2.5 to 4 cm long, 1.5 to 2.5 cm wide, the nerves obscure, frequently only a subbasal pair, never more than two pairs, evanescent, reticulations obsolete; petioles ciliate-setose, 2 to 3 mm long. Flowers axillary, solitary or in pairs or threes, their slender, conspicuously ciliate-setose, slender pedicels 1 to 2.5 cm long. Calyces densely and conspicuously ciliate-setose, the tube about 3 mm long, the lobes triangular, acute, less than 1 mm long. Corolla glabrous, somewhat turbinate, 5.5 mm long, the lobes recurved, broadly ovate, obtuse, 1.5 mm long. Filaments glabrous, 1.5 to 2 mm long, the anthers about 1.4 mm long, their apices somewhat produced.

LUZON, Nueva Vizcaya Province, Caraballo Mountains, *Loher 13693*, March, 1915.

A remarkably distinct species, distinguished among all hitherto known Philippine forms by its conspicuously ciliate-setose calyces, the setæ being reddish brown, spreading, 0.5 to 2.5 mm in length, similar to those on the long slender pedicels, the branchlets, petioles, and leaves. The scattered setose hairs on the lower surface of the leaves spring from small dark-colored glands, these glands persisting after the setæ fall.

Known only by the type collection (M, C), which is, indeed, remarkably distinct. The pedicels bear, beside the reddish bristles, a dense pubescence of minute white simple hairs. The massed descending bristles on the calyx do not extend onto the lobes, which are glabrous except for the finely white-ciliate margins. The anthers are of the same structure as in *D. calelanensis* and *D. luzonica,* but are smaller. The pistil is glabrous; the ovary about 1.5 mm high, the style about 2 mm long.

2. **DIPLYCOSIA TRINERVIA** Elmer. Plate 2, figs. 1–2.

Diplycosia trinervia ELMER in Leafl. Philip. Bot. 3 (1911) 1102; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 247.

Diplycosia urdanetensis ELMER in Leafl. Philip. Bot. 7 (1915) 2628; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 247.

Frutex epiphyticus, ramulis juvenilibus plus minusve setosis. Folia alterna; petioli 3–7 mm longi, glabrescentes; laminae ellipticae, ad oblanceolatae, 3.5–7 cm longae, c. 2 cm latae, basi cuneatae, apice subacuminatae, apiculatae, supra glabrae, subtus punctatae, margine recurvae, serrulatae, in juventate setoso-ciliatae, trinerviae, reticulationibus obsoletis. Flores solitarii ad trini in fasciculis axillaribus; pedicelli gracili, parce setosi, 10–20 mm longi; bracteolae acutae c. 1 mm longae, in costulo margineque ciliatae et glanduloso-ciliatae; calyx obconicus, c. 4 mm latus, lobis 5 acutis, margine quasi bracteoli; corolla campanulata vel subcylindrica, viridicans, c. 5 mm longa, lobis 5 obtusis; stamina 10, filamentis glabris sigmoideis 2.5–3.5 mm longis, antheris lanceolatis 3 mm longis, dimidiis superioribus in tutulis connatis angustatis, per rimis introrsis apicalibus 0.5

mm longis dehiscentibus; ovarium subglobosum glabrum 2 mm latum; stylus glaber c. 5 mm longus.

The original description reads:

An epiphytic shrub; stems quite rigid, branched; wood tough, covered with gray bark; twigs especially the younger portion brown when dry and covered with similarly colored setose hairs. Leaves conspicuously scattered along the branchlets, alternate, rigidly coriaceous, oblong elliptic, similarly tapering toward both acute ends, the apex terminated into a very short mucronate point, glabrous on the upper sublucid surface, paler green beneath, brown in the dry state, entire, margins subinvolute and with occasional bristle-like brown hairs, beneath glandular punctate or with few hairs along the nerves or from the glands, the average blades 5 cm. long, 2.5 cm. wide across the middle, the smaller ones similar in shape; midrib conspicuous beneath, impressed above, usually with only 1 pair of lateral nerves suboppositely arising from 3 to 5 mm. from the base and curvingly extending clear to the apex, occasionally a minor pair arises from the base and runs along the margin, the upper oblique secondary nerves obscure or obsolete; petiole stout, 5 mm. long, brown, setose but ultimately glabrous. Flowers few clustered in the leafy axils, pendulous; pedicels slender, brown hairy; recurved, 1.25 cm. long or longer, subtended at the base by minute bracts; involucral disk 3 mm. wide across the rim, 1.5 mm. high, pectinately glandular along the margin, otherwise nearly glabrous; calyx greenish, 5 mm. long, tapering from base to the broad 5-dentate throat, similarly glandular along the edges, the teeth rather blunt; corolla glabrous, 7.5 mm. long, campanulate, the 5 short acute segments reflexed; stamens 10; filaments flattened toward the base, glabrous, 3.5 mm. long, inserted on the base of the corolla; anthers nearly as long, attached to the back below the middle, gradually tapering from the bilobed base to the sterile apical portion, minutely pulverulent, without appendages; ovary superior, flattish globose, glabrate, 2.5 mm. across; style also glabrous, 6 mm. long, columnar, bearing a terminal but not enlarged stigma; fruit not seen.

Type specimen 11676[a], *A. D. E. Elmer*, Todaya (Mt. Apo), District of Davao, Mindanao, September, 1909.

This *Diplycosia* was collected in the elfinwoods on the summit of Mount Calelan. See note under the preceding [i. e. under *D. apoensis*].

The original description of *D. urdanetensis* reads:

Epiphytic and shrubby; stems few from the same cluster, mostly descending, 1 m long or longer, rather sparingly branched; wood white, rigid and covered with a smooth dark brown bark, the younger portions of the twigs glabrous, old branchlets roughened by the large leaf scars. Leaves numerous, drying dull brown on both sides, glabrous, marginal portion curved upon the nether side, entire or subentire above the middle, horizontal or descending, obtuse at both ends or acute and mucronately pointed at the apex, oblong or occasionally obovate, the larger ones 7 cm long with the petiole, 2.5 cm wide across the middle, the smallest ones broadly oblanceolate, shining and nearly black in the dry state on the upper surface, dull brown beneath; midvein straight, prominent beneath, cani-

culate above; usually only one pair of lateral veins arising 8 mm from the base, ascending, curved and connivent into the apex; petiole at least 5 mm long, thick, glabrate, caniculate above, reddish brown on the dry specimens. Flowers in small axillary clusters; slender pedicel slightly recurved, whitish, 1.33 cm long, its distal end expanded into a saucer shaped disk 2.5 mm across and whose truncate edge is minutely ciliate; calyx 3.5 mm high, cup shaped, rigidly coriaceous, glabrate, the lower two thirds united, the apical portion terminated into 5 rather broad teeth whose apices are mostly acute, the outer marginal portion of the teeth puberulent; corolla greenish white, 4.5 mm long, the 5 segments contiguous in the bud state, ultimately free and oblong, glabrous, obtuse at the apex; stamens 10, included, becoming exposed by pushing off the corolla, inserted upon the basal inner portion of a glabrous irregularly lobed or pointed rim; filaments 2.5 mm long; also glabrous, compressed and widened toward the base; anthers erect, basifixed, nearly as long, auriculately lobed at the base, gradually tapering to the blunt apex, on the inner side apparently with a pair of linear sac-like extensions from above the middle to nearly the base; ovary subglobose, 2 mm in diameter, glabrous and almost black in the dry state, obscurely rugose; neck at least 3 mm long, straight, glabrous, terminated by a minute stigma.

Type specimen number 13800, *A. D. E. Elmer*, Cabadbaran (Mt. Urdaneta), Province of Agusan, Mindanao, September, 1912.

Discovered in the stunted moss laden summit woods of mount Urdaneta at 6,500 feet elevation. 'Minamol' in Manobo.

From *Diplycosia trinervia Elm.* it differs mainly in its glabrous or nearly glabrous not setose character; from *Diplycosia merrittii Merr.* in having thinner more elongated trinervous leaves; and from *Diplycosia calelanensis Elm.* by the slender or longer pedicels and distinctly pointed leaves.

MINDANAO, Davao Province, Mount Calelan, *Elmer 11676a* (W, type): Agusan Province, Mount Urdaneta, *Elmer 13800* (M, W, S, type of *D. urdanetensis*).

The cotype of *D. trinervia* is unsatisfactory, but seems to match the type material of *D. urdanetensis*. The difference in bristliness is real, but it is a matter of degree, not absolute. As to the differences in length of corolla and style that appear in the original descriptions, I cannot judge, since the type bears no mature flowers. It is, of course, only by description that I know the stamens of *D. trinervia*. They are apparently the same as the quite distinctive stamens seen in the type material of *D. urdanetensis:* and I conclude that the latter species, though very much better typified, is to be reduced. The anthers are about twice as long as, but no wider than, those of any other Philippine species. A comparison of the above descriptions with Smith's full description of *D. pilosa* strongly suggests that reduction be carried farther; not having seen material of *D. pilosa,* I refrain from reducing *D. trinervia* to that species. *Diplycosia celebensis* J. J. Smith, as well as several of the species from Mount

Kinabalu which were described by Stapf, appear, from the descriptions and figures, to have anthers of the same character.

3. DIPLYCOSIA LUZONICA (A. Gray) Merrill. Plate 2, figs. 3–6; Plate 3; Plate 4, fig. 1.

Diplycosia luzonica (A. GRAY) MERRILL in Philip. Journ. Sci. 2 (1907) Bot. 293, 3 (1908) Bot. 378, 5 (1910) Bot. 371, Enum. Philip. Fl. Pl. 3 (1923) 247.

Gaultheria luzonica A. GRAY in Proc. Am. Acad. Sci. 5 (1861) 324.

Diplycosia fasciculiflora MERRILL in Philip. Journ. Sci. 10 (1915) Bot. 52, Enum. Philip. Fl. Pl. 3 (1923) 246.

Diplycosia merrittii MERRILL in Philip. Journ. Sci. 2 (1907) Bot. 293, 3 (1908) Bot. 378, Enum. Philip. Fl. Pl. 3 (1923) 246.

Diplycosia scandens MERRILL in Philip. Journ. Sci. 1 (1906) Suppl. 219, Enum. Philip. Fl. Pl. 3 (1923) 247.

The original description reads:

GAULTHERIA (DIPLYCOSIA) LUZONICA (sp. nov.): foliis ovalibus utrinque acuminatis supra glabris subtus ramisque novellis parce strigoso-hispidis; pedunculis fasciculatis petiolo longioribus; bracteolis connatis orbiculatis. Luzon, in the Majaijai Mountains; in fruit.

This may be amended to read as follows:

Arbor, frutex, vel suffrutex, terrestris vel epiphyticus, ad 6 m altus, ramulis junioribus dense fulvo-setosis; folia alterna, petiolis in juventate setosis, 3–7 mm longis, laminis in juventate utrinque setosis 2–10 cm longis, 1–6 cm latis, figura mutabilissima, lanceolata, ovata, ovale, elliptica, obovata, vel oblanceolata, apiculatis, margine recurvis, prope apicem serrulatis, setoso-ciliatis, venatione mutabile interdum obsoleto, foliis minoribus saepius triplinerviis, majoribus subpenninerviis, flores trini ad octoni in fasciculis axillaribus, pedicellis setosis hirtellisque rare subglabris 3–15 mm longis; bracteolae connatae, ovatae, c 1.5 mm longae, glabrae vel hirtellae, margine ciliatae et glanduloso-ciliatae; calyx obconicus 3–5 mm latus, glaber ad dense hirtellus, lobis 5 margine quasi bracteolae; corolla subglobosa glabra vel parce hirtella, 3–4 mm longa, alba ad rosea, lobis 5 ovatis, recurvis, c. 1 mm longis, parce glanduloso-ciliatis vel integris; stamina 10, filamentis glabris 2–3 mm longis, antheris oblongis 1.5–2 mm longis, tubulis apicalibus 0.2–0.4 mm longis; discus obscurus lobatus c. 0.3 mm altus; ovarium glabrum subglobosum 1.5 mm latum; stylus glaber 2–3 mm longus; pedicelli fructiferi accreti, calyx globose accretus, c. 7 mm latus, carnosus, niger, fructum c. 4 mm latum includens; semina fulva applanata subtriangularia c. 1 mm longa.

The original description of *D. fasciculiflora* reads:

Species *D. parvifoliæ* affinis, differt floribus fasciculatis, pedicellis brevioribus, ramis ramulisque glabris, vix setosis.

Apparently scandent, probably epiphytic, the branches terete, glabrous, dark reddish-brown, the branchlets paler, glabrous, not at all setose. Leaves coriaceous, elliptic to elliptic-oblong, dull, 2 to 4 cm long, 1 to 1.5 cm wide, when young with few, long, slender, brown, setose hairs on the margins, and scattered ones on both surfaces, when mature quite glabrous, the midrib prominent, lateral nerves obsolete, base and apex acute; petioles 2 to 3 mm long, slightly setose. Flowers small, pedicelled, in axillary fascicles, up to 8 in each fascicle, the pedicels slender, glabrous, 5 mm long or less, the basal bracts small, the apical bracteoles very broadly ovate, obscurely acuminate, puberulent. Calyx glabrous, somewhat accrescent and 2.5 mm long, the lobes triangular, acute, about 1 mm long. Corolla and stamens not seen.

LUZON, Subprovince of Ifugao, Mount Polis, *Bur. Sci. 19758 McGregor*, February 1, 1913.

A species very similar and manifestly closely allied to *Diplycosia parvifolia* Merr., of Negros, strongly resembling that species in vegetative characters, especially in the obsolete lateral nerves and reticulations. It differs from that species, however, in its flowers being fascicled, not solitary, its longer pedicels, and somewhat larger leaves.

The original description of *D. merrittii* reads:

Frutex pseudoepiphyticus scandens, inflorescentiis excepti, glabra; foliis coriaceis oblongo vel elliptico-ovatis, rariter oblongo-lanceolatis, breviter acuminatis, 6 ad 10 cm. longis, basi acutis nervis utrinque 2 vel 3, subtus prominentibus; flores axillares, fasciculati; corolla ovoidea, 6 ad 7 mm. longa.

A scandent pseudoepiphytic shrub often 6 m. high, glabrous except the inflorescence. Branches gray or brown, terete, the younger ones angular. Leaves coriaceous, oblong-ovate to elliptical-ovate, rarely oblong-lanceolate, 6 to 10 cm. long, 2 to 5 cm. wide, the base acute, the apex slightly acuminate, the margins obscurely denticulate, recurved, paler and glandular punctate beneath; nerves 2 to 3 on each side of the midrib, ascending, impressed above, rather prominent, the reticulations nearly obsolete; petioles stout, 4 to 8 mm. long, rugose. Flowers pink, fascicled, 2 to 8 in each axil, the pedicels slender, slightly pubescent, 1 to 1.5 cm. long, the apical bracts two, orbicular-ovate, 1.3 mm. long. Calyx very slightly pubescent, 3.5 mm. long, the lobes ovate or narrowly ovate, acute, 2 mm. long. Corolla ovoid, narrowed below, 6 to 7 mm. long, the lobes 5, ovate, broadly acuminate, 2 mm. long, reflexed. Stamens 10, glabrous; filaments 3 mm. long; anthers oblong, 1.5 mm. long. Ovary glabrous, style 2 mm. long. Fruit ovoid or subglobose, soft, fleshy, 1 cm. in diameter, black when mature.

In ridge forests at 1,400 m. alt. (No. 5670) (type), very abundant, the fruit edible but nearly tasteless; also collected by *Merritt* in June, 1906, at an altitude of from 1,600 to 1,700 m. (Nos. 4413, 4415, 4437). The same form has been collected in Palawan, Victoria Peak (666 *Foxworthy*) March, 1906.

Of the Philippine species of this genus, apparently most closely related to DIPLYCOSIA LUZONICA (A. Gray) (*Gaultheria luzonica* A. Gray), from Mount Banajao and Mount Santo Tomas, Luzon. I have before me a single leaf from the type of *Gray's* species kindly supplied by Dr. *J. N.*

Rose of the U. S. National Museum. No. 5932 *Elmer* from Mount Santo Tomas seems to match it exactly. The species proposed above differs from this in its larger, differently shaped leaves, much longer pedicels and more prominently nerved leaves, the venation in the two species being quite different. I have seen no flowers of *Gaultheria luzonica.*

The original description of *D. scandens* reads:

A scandent more or less hispid pseudo-epiphytic shrub reaching a height of 4 m., with ovate or narrowly-ovate, short acuminate or acute leaves and fascicled flowers. Branches slender, gray or brown, the younger ones rather strongly beset with long brown appressed bristly hairs. Leaves coriaceous 3 to 4.5 cm. long, 1.5 to 2.5 cm. wide, the base rounded, entire, gradually narrowed above, glabrous on the upper surface or with very few hairs, beneath paler and with scattered bristly hairs; petioles about 3 mm. long, densely bristly hairy; nerves 2 on each side of the midrib, both below the middle of the leaf. Flowers axillary, 3 to 6 in each axil, the pedicels pubescent, about 4 mm. long, 2-bracteolate at the apex, the bracteoles 1 mm. long, broader than long, ciliate. Calyx teeth broad, ovate, obtuse, about 1 mm. long, ciliate. Corolla white, about 5 mm. long, 3.5 mm. in diameter, the lobes broadly ovate, acute, reflexed, nearly 2 mm. long. Stamens 10; filaments 2 mm. long, not dilated below, glabrous; anthers about 1.2 mm. long, not horned. Ovary superior, glabrous, globose, 5-celled, cells many-ovuled; style about 2.2 mm. long.

LUZON, District of Lepanto, Mount Data (4597 *Merrill*) November 4, 1905. Pseudoepiphytic on mossy tree trunks in ravines, mossy forest at about 2,250 m. The first species of the genus to be reported from the Philippines, unless *Gaultheria* (*Diplycosia*) *luzonica* A. Gray, Proc. Am. Acad. 5 (1862) 324, proves to be a true *Diplycosia*. Gray's description is so short that I have been unable to locate his species, the type being from the collections made by members of the Wilke's [!] U. S. Exploring Expedition from "Luzon, in the Majaijai Mountains" (Mount Banajao). Dr. B. L. Robinson informs me that the type is not in the Gray Herbarium. A second, apparently closely related but glabrous species, is represented by No. 5932 *Elmer*, Province of Benguet, Luzon, the specimens with fruit only.

LUZON, Laguna Province, Mount Banahao, *U. S. Expl. Exped. s. n.* (W; M, fragm. ex W; type), *Loher 6208* (M), *For. Bur. 7884 Curran and Merritt* (M, W), *For. Bur. 7892 Curran and Merritt* (M), *Bur. Sci. 6851 Robinson* (M), *Bur. Sci. 19585 Ramos* (M, W), *Foxworthy s. n.* (M), *Quisumbing s. n.* (M), *Quisumbing 1140* (M), *Quisumbing 1306* (M), *For. Bur. 30076 Sulit* (C): "Luzon Central," Bulacloco, *Loher 3771* (W): Mountain Province, Benguet Subprovince, *Clemens 17217* (C); Mount Simacoco, *Bur. Sci. 40327 Ramos and Edaño* (M); Mount Pulog, *For Bur. 18048 Curran, Merritt, and Zschokke* (M, W), *Bur. Sci. 44884 Ramos and Edaño* (M, C); Mount Pulogloco, *Bur. Sci. 40397 Ramos and Edaño* (M); Mount Baudan, *Bur. Sci. 40307 Ramos and Edaño* (M): Lepanto Subprovince, Mount

Data, *Merrill 4579* (M, W, type of *D. scandens*), *Clemens 13691* (C), *Clemens 17822* (C); Balbalasan, *For. Bur. 5693 Klemme* (M): Abra Subprovince, *For. Bur. 14613 Darling* (M): Bontoc Subprovince, Mount Pukis, *Bur. Sci. 37811 Ramos and Edaño* (M): Ifugao Subprovince, Mount Polis, *Bur. Sci. 19758 McGregor* (M; type of *D. fasciculiflora*). MINDORO, Mount Halcon, *For. Bur. 4413 Merritt* (M), *For. Bur. 4415 Merritt* (M), *For. Bur. 4437 Merritt* (M), *Merrill 5670* (M, W, type of *D. merrittii*). PALAWAN, Mount Victoria, *Bur. Sci. 666 Foxworthy* (M, W). NEGROS, Cuernos Mountains, *Elmer 10184* (M, W); Canlaon Volcano, *Merrill 236* (M, W). MINDANAO, Misamis Province, Mount Malindang, *For. Bur. 4776 Mearns and Hutchinson* (M): Bukidnon Province, Mount Lipa, *Bur. Sci. 38540 Ramos and Edaño* (M).

At elevations from 360 (Mount Malindang) to 3,000 meters (Mount Pulog); mostly at about 2,000 meters.

The specimens here cited are by no means perfectly uniform: thus the plants from the neighborhood of Mount Data (*D. scandens*) have rather small, ovate, and sharp-pointed leaves, and very short pedicels; the type material of *D. fasciculiflora* appears to be merely an individual variation with still smaller leaves; plants from the neighborhood of Mount Pulog have markedly fine-hairy calyces; and those from Mount Halcon (*D. merrittii*) have especially large leaves and long pedicels. I have not seen topotypic material of *D. merrittii* in young stages; it is possible that the young leaves are not setose, in which case the species might possibly be retained. However, the whole series of specimens gives an appearance of specific identity; and I believe that if all the material from Mount Banahao now present and available had been collected and identified soon enough, neither *D. scandens* nor *D. merrittii* would have been described.

4. **DIPLYCOSIA CALELANENSIS Elmer.** Plate 5, fig. 1.

Diplycosia calelanense ELMER, in Leafl. Philip. Bot. 3 (1911) 1103; *D. calelanensis* MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 246.

Diplycosia glabra MERRILL in Philip. Journ. Sci. 14 (1919) 442, Enum. Philip. Fl. Pl. (1923) 246.

Planta lignosa, terrestris vel epiphytica, ad 4 m alta, caulibus glabris vel ramulis juvenilibus rare setosis; folia alterna, petiolis c. 5 mm longis, laminis subcoriaceis 3–6 cm longis, 1–4 cm latis, figura mutabilissima, oblonga, elliptica, ovata, obovata, vel oblanceolata, basi rotundatis ad cuneatis, apice rotundatis, obtusis, vel acutis, rare acuminatis, saepissime apiculatis, glabris setulis marginalis raris exceptis, supra lucidis, subtus punctatis,

margine recurvis, integris vel distante indentulatis, venatione mutabile saepe subobsoleto; flores axillares, rare solitarii, saepius bini ad seni in fasciculis; pedicelli floriferi 2–8 mm longi, glabri, hirtelli, vel rare setosi; bracteolae 1–2 mm longae, connatae, glabrae vel in costulo hirtellae, margine basi glandulosociliatae, apice simpliciter ciliatae; calyx obconicus 3–5 mm latus, glaber, lobis 5 acutis vel obtusis, 1–1.5 mm longis, margine quasi bracteolae; corolla alba ad rosea, in sicco nigra, subglobosa, glabra, 3–5 mm longa, lobis 5 minutis; stamina 10, filamentis glabris, 2.5–3 mm longis, antheris lanceolatis vel ovatis c. 1.5 mm longis, apice bitubulosis, tubulis 0.3–0.4 mm longis; discus obscurus lobatus c. 0.3 mm altus; ovarium sphaericum glabrum, 1–1.5 mm longum stylus glaber 2–3 mm longus; pedicelli fructiferi modice creti, calyce globoso creto, c. 7 mm lato, carneo, nigro, fructum includente.

The original description reads:

A shrubby epiphyte; stems 1 m long and branched; the main branches quite rigid, the ultimate ones rather lax and flexible, covered with smooth or thinly shredded gray bark; young twigs brownish in the dry state and sparsely setose hairy but soon becoming glabrous. Leaves alternatingly scattered, ascending, flat or only slightly recurved, rigidly coriaceous, deep shining green on the glabrous upper surface; much lighter or even yellowish green beneath, drying dull brown, quite variable in size, the larger blades 4 cm long by 2 cm wide a trifle above the middle, obovate or the smaller ones oblanceolate, the entire margins subinvolute and occasionally with few hairs, cuneate at the base, rounded at the other end and with a short mucronate point, beneath punctately glandular; midrib raised beneath, impressed above, usually with 3 lateral pairs; the basal pair arising a few mm above the base and extending one half of the blade, the middle pair more conspicuous and arched clear around to the apex, the upper pair obscure or obsolete; petiole glabrous or sparsely hairy, stout, not exceeding 5 mm in length. Flowers in small axillary fascicles, subpendulous; pedicels 5 mm long, subrecurved, provided with few crisp hairs, subtended at the base by short rather thick imbricate bracts; calyx green, subtended at the base by a saucer shaped and a glandularly margined rim 3 mm wide, 5 mm long, glabrate except the glandular margins of the triangularly shaped 5 teeth; corolla greenish yellow, short cylindric, 5 mm long, nearly as wide, the 5 small recurved segments forming a truncate apex, glabrous; stamens 10, all equal and fertile; filaments also greenish, subcompressed, glabrate, 2 mm long, inserted upon the inner basal portion of the corolla tube; anthers 1.5 mm long, pulverulent, attached to the back below the middle, oblong and with truncate ends, slightly wider across the base, flattened toward and dehiscent at the apex, without appendages; ovary glabrous, superior, 2 mm wide, 1.5 mm high; style thick, 3 mm long, fusiformly thickened at the middle, also glabrate and greenish; stigma terminal, not enlarged; fruit not seen.

Type specimen 11681, *A. D. E. Elmer*, Todaya (Mt. Apo), District of Davao, Mindanao, September, 1909.

Collected in elfinwoods densely clothed with mosses and scale-mosses at 8,500 feet of Mt. Calelan. Called by the Bagobos 'Limatmat.'

Associated with other allied species of *Diplycosia*, but most closely related to the following [i. e. to *Elmer 11676*, identified as *D. luzonica*].

The original description of *D. glabra* reads:

Frutex epiphyticus, glaber, vel ramulis junioribus parcissime setosis; foliis ellipticis ad oblongo-ellipticis, acutis vel brevissime apiculatis, basi acutis, usque ad 6 cm longis, in siccitate olivaceo-brunneis vel pallidis, nitidis, nervis utrinque 2, tenuibus, supra leviter impressis, subtus obsoletis floribus axillaribus, solitariis vel fasciculatis, pedicellatis, bracteolis late ovatis, 1.5 mm longis, margine leviter ciliatis, calycis [calycibus] circiter 2 mm longis, lobis late ovatis, obtusis, 1.5 mm longis.

A glabrous, erect, epiphytic shrub, attaining a height of from 3 to 4 m, the very young branchlets sometimes with a very few slender setae. Leaves coriaceous, elliptic to oblong-elliptic, 2 to 6 cm long, 1 to 2.5 cm wide, brownish-olivaceous or pale when dry, shining, the lower surface with small scattered, brownish glands, the base acute, the apex usually acute and ending in a short, stout, blunt apiculus; lateral nerves 2 on each side of the midrib, slender, slightly impressed on the upper, obsolete on the lower surface, curved, the upper pair leaving the midrib at or near the middle of the leaf, the reticulations obsolete; petioles about 2 mm long. Flowers axillary, solitary or few in a fascicle, their pedicels about 5 mm long, the apical bracteoles connate, broadly ovate, acute or slightly acuminate, margins sparingly ciliate, 1.5 mm long. Calyx about 2 mm long, the lobes broadly ovate, obtuse, 1.5 mm long, their margins slightly ciliate. Corolla not seen. Fruit soft, fleshy, bluish-black, when dry brownish or black, about 5 mm long.

LUZON, Benguet Subprovince, Pauai, *Bur. Sci. 31784* Santos, April 22, 1918 (type), *Bur. Sci. 8509 McGregor*, June, 1909, *For. Bur. 14434 Darling*, January, 1909, *Copeland, s. n.*, May, 1913, in the mossy forest, altitude about 2,300 meters. Igorot name *dugui-is*.

Among the Philippine species this is most closely allied to *Diplycosia calelanensis* Elm., from which it is readily distinguished by its nerves being obsolete on the lower surface of the leaves. Among the extra-Philippine species its alliance is manifestly with the Javan *Diplycosia heterophylla* Blume, but its leaves are different in shape, never acuminate, with shorter petioles, while the venation is distinctly different.

MINDANAO, Davao Province, Mount Calelan, *Elmer 11681* (W; type of *D. calelanense*); Mount Matutum, *Copeland s. n.* (M). LUZON, Sorsogon Province, *Copeland s. n.* (M): Rizal Province, Montalban, *Loher 12383* (M, C); Pinauisan, *Loher 12425* (M, C): Mountain Province, Benguet Subprovince, Mount Santo Tomas, *Elmer 5932* (M, W), *Williams 1341* (M, W), *Bur. Sci. 5466 Ramos* (M, W); Baguio, *Elmer 14262* (M, W); Mount Ugo, *Bur. Sci. 5726 Ramos* (M); Pauai, *For. Bur. 14434 Darling* (M), *Bur. Sci. 8509 McGregor* (M), *Bur. Sci. 31784 Santos* (M; type of *D. glabra*).

The leaves of both of the specimens from Mindanao (typical *D. calelanensis*) are obtuse or rounded. Those of the specimens from Pauai (*D. glabra*) and from Rizal are uniformly elliptic, with acute apices; but the Rizal plants seem to be distinguishable by flowers on longer pedicels. The leaves of specimens from Mount Santo Tomas are very variable; some resemble so closely the leaves of *D. luzonica* that Merrill, with a leaf of the type specimen of *D. luzonica* before him, regarded them as typical representatives of that species, as he remarked in describing *D. merrittii.* But other leaves of these plants match perfectly those of the type specimens of *D. calelanensis* and *D. glabra.*

From a comparison of the descriptions given above with Smith's elaborate description of *D. heterophylla,* I conclude that *D. calelanensis* can be distinguished by small flower parts in general, and especially by smaller anthers; and by anthers resembling those of *D. luzonica* rather than those of *D. trinervia.* Other closely related species are *D. punctulata* Stapf, of Borneo, and *D. edulis* Schlechter, of Northeast New Guinea.

5. **DIPLYCOSIA OPACA** C. B. Robinson. Plate 5, fig. 2.

Diplycosia opaca C. B. ROBINSON in Philip. Journ. Sci. 6 (1911) Bot. 355; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 247.

The original description reads:

Arbuscula epiphytica, inflorescentiis exceptis glabra: inflorescentiis axillaribus, 1- ad 3-floris, pedicellis brevibus: foliis ellipticis, coriaceis, basi acutis, apice retusis vel rarius truncatis, crasse apiculatis, margine integris, revolutis; venis utrinque circa 3, obscuris.

Flowers in the axils of present or fallen leaves, 1 to 3 at each node, fascicled, the pedicels 2 to 4 mm long, densely covered with nearly appressed pubescence: bracts at the base of the flowers paired, ovate obtusely acuminate, 2 mm long, pubescent near the margins and ciliate, together resembling a *Cosmarium;* calyx pinkish, urceolate, 3 mm long, divided two-thirds of the way to the base into 5 imbricate, ovate, subacute or obtuse ciliate lobes; corolla still undivided, 2 to 2.5 mm long; stamens 10, 1 mm long, the filaments longer than the unappendaged anthers; ovary glabrous, less than 1 mm long, umbilicate, 5-celled, many-ovuled; style very short, the undivided stigma barely exerted [exserted] from the umbilicus.

An epiphytic shrub, about 1 m high, the vegetative parts entirely glabrous, the bark of the older stems cinnamon-brown, that of the younger branches more often gray: leaves with petioles 5 to 9 mm long, the lamina coriaceous, elliptic, 4 to 8.5 cm long, 2 to 4 cm wide, the base acute, the margins entire, revolute, the apex retuse or merely truncate, shortly and stoutly apiculate, the under surface with scattered, minute, black, glandular dots; all venation except the midrib very indistinct, but the lamina cer-

tainly triplinerved, with apparently two additional veins on each side of the midrib.

LUZON, Province of Tayabas (Infanta), Mount Binuang, in mossy forest at an elevation of 900 m, *Bur. Sci. 9385 Robinson*. The leaf-apex seems entirely different from that of any other species of the genus, at once separating it from *D. merrittii*, its nearer Philippine ally.

Known only by the type collection (M, W); this bears only immature flower buds, on which the original description of the flowers was evidently based. With doubt I hold this distinct from *D. calelanensis*, from which it differs in the larger leaves. The leaves are nearly all obtuse or rounded, but one of them is briefly acuminate, as in some collections of *D. heterophylla*.

6. DIPLYCOSIA BACLAYANENSIS Elmer.

Diplycosia baclayanensis ELMER in Leafl. Philip. Bot. 3 (1911) 1100; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 246.

Fruticulus epiphyticus (an semper?), petiolis glabris crassis 5–7 mm longis, foliis crasse coriaceis, ovatis, oblongis, vel obovatis, c. 6–7 cm longis, 3–4 cm latis, apice obtusa vel rotundata, apiculata, supra glabra, venatione impresso manifesto, margine recurvis, rare indentulatis, subtus minute punctatis, venatione subobsoleto; flores in fasciculis axillaribus (foliis subtendentibus interdum disjunctis), in pedicellis hirtellis glandulosisque, nunquam setosis, 5–8 mm longis; bracteolis c. 1.5 mm longis, glabris, margine ciliolatis et glanduloso-ciliolatis; calyx glaber, c. 4 mm longa, lobis 5 ciliolatis et glanduloso-ciliolatis; corolla alba, c. 5 mm longa, lobis 5 minutis; stamina 10, filamentis c. 2 mm longis, antheris c. 1.5 mm longis; ovarium glabrum globosum, c. 2 mm longum; stylus glaber, c. 3 mm longus.

The original description reads:

An epiphytic shrub; stem 1 to 2 m. long, rigid, branched, the larger ones 2 to 3 cm. thick ascending; wood greenish white, with a large pith; bark brown or grayish, smooth or becoming thinly shredded; twigs yellowish gray and smooth. Leaves thickly coriaceous, dull green above, much lighter beneath, ascending, the young ones reddish, flat, the entire margins rolled upon the under side in the dry state, alternatingly scattered or occasionally clustered in subwhorls, glabrous, minutely punctate beneath, ovately oblong, rounded or obscurely obtuse at the apex which is terminated by a short mucronate point, base obtuse or rounded, the median blades 7 cm. long and 4 cm. wide above the middle, drying brown; petiole 5 mm. long, also glabrous, stout, brown, deeply indented into the cortex of the branchlets; midrib conspicuous beneath, impressed on the upper side, with 2 to 4 lateral nerves on each side; the heavier pair of lateral ones arising 5 to 10 mm. from the base and curvingly extending clear to the apex, reticulations absent on both sides. Flowers waxy white, pendulous, severally clustered

from the leaf axils or axils of their scars; pedicels 8 mm. long, spreading, usually recurved, reddish and puberulent, quite slender, at the base subtended by small imbricated brown bracts; involucral disk 3 mm. across, only one half as high, glabrate except the finely pectinate more or less glandular margins; calyx 3.5 mm. long, subglabrous except the margins of the 5 teeth, greenish; corolla bluntly elliptish, white, 5 mm. long, glabrous, the short 5 teeth reflexed; stamens 10; filaments subcompressed, 2 mm. long, inserted upon the base of the corolla; anthers 1.5 mm. long, widest across the obscurely bilobed base, finely pulverulent or papillate, dorsally attached, without appendages although the apical portion is much narrower and thinner; the glabrous ovary globosely compressed, 2.25 mm. across, superior; style columnar, 3 mm. long, terminated by a minute stigma; fruit not seen.

Type specimen 11595, *A. D. E. Elmer*, Todaya (Mt. Apo), District of Davao, Mindanao, August, 1909.

Collected in a dense moss covered forested basin at 6500 feet at Baclayan or the upper camping place of mount Apo. It was taken from the lower limbs of a large tree. The Bagobo name is 'Sigbut-ta-cayo.'

MINDANAO, Davao Province, Mount Apo, *Elmer 11595* (W; cotype). LUZON, Nueva Vizcaya Province, Caraballo Mountains, *Loher s. n.* (C).

The cotype is a very poor specimen, without fruit or mature flowers, and with all of the seven leaves more or less distorted, as if by the work of insects. The specimen from Nueva Vizcaya is identified with doubt; like the cotype, it lacks flowers and fruit, although showing pedicels clearly; the leaves are in good condition. It appears from the descriptions that *D. baclayanensis* is closely related to *D. kinabaluensis* Stapf, but that the latter has flowers about twice as large.

7. DIPLYCOSIA APOENSIS Elmer. Plate 4, fig. 2.

Diplycosia apoense ELMER in Leafl. Philip. Bot 3 (1911) 1101; *D. apoensis* MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 246.

Fruticulus epiphyticus vel procumbens, ramulis dense setosis; folia alterna, petiolis c. 3 mm longis, setosis; laminis ovatis, trinerviis, 2–3 cm longis, c. 1.5 cm latis, basi obtusis vel rotundatis, apice acutis vel acuminatis, supra lucidis, in juventate setosis, subtus setosis vel in senectute punctatis, margine recurvis; flores solitarii vel pauci in fasciculis, axillaris; pedicelli usque ad 5 mm longis, setosi et glandulosi; bracteolae connatae, c. 1.5 mm longae, margine glanduloso-ciliatae; flores quasi D. luzonicae.

The original description reads:

Epiphytes or sprawling over moss covered ground; stem 5 dm. long, branched; wood quite hard, covered with grayish brown bark; twigs provided with similarly colored setose hairs, the young portion densely covered

with reddish brown hairs. Leaves alternate, copiously scattered along the branchlets, elliptic, 2.5 cm. long by 1.5 cm. wide across the middle, rigidly coriaceous, shining green on the upper side and beset with strigose hairs, beneath much paler green and duller, apiculately obtuse at apex, base rounded or obtuse, the entire margins curved upon the under side, curing brown, beneath setose hairy; nerves 3 from the base, impressed on the upper side, the midrib rather conspicuous beneath clear to the apex; the lateral pair less conspicuous, subopposite, arising 1 to 3 mm. from the base, curvingly extending clear to the apex, other nerves obsolete; petiole 3 mm. long, stout, similarly hairy. Flowers solitary or few clustered from the leaf axils; pedicels at most 5 mm. long, subrecurved, scurfy brown or with crisp hairs, subtended at the base by brown and minutely fringed imbricate bracts; involucral disk broadly bilobed, 3 mm. wide across the pectinately fringed margins, only one half as high; calyx 5 mm. long, 4 mm. across, rather broad clear to the base, glabrous except the pectinately fringed glands along the margins; segments triangularly acute, one half the length of the calyx; corolla glabrous, subcampanulate, with 5 acute or obtuse slightly reflexed teeth; stamens 10, inserted near the base of the corolla; filaments glabrous, wider below the middle, 2 to 3 mm. long; anthers without horns, 2 mm. long, finely pulverulent, widest across the minutely bilobed base, dorsally attached just below the middle; ovary also glabrous, subglobose, superior; style smooth, strict, a few mm. long; stigma terminal, minute; fruit not seen.

Type specimen 11676[b], *A. D. E. Elmer*, Todaya (Mt. Apo), District of Davao, Mindanao, September, 1909.

Discovered in elfinwoods laden with mosses and scale-mosses at the summit of mount Calelan. This as well as *D. trinervia Elm.* were collected and cured under one number, namely 11676, which is nearest but not at all typical *D. luzonica (Gray) Merr.* They can distinctly be separated at once even in the dry state. Number 11681, the type material of *D. calelanensis Elm.* is another very closely allied species.

MINDANAO, Davao Province, Mount Calelan, *Elmer 11676*[b] (M; type): Bukidnon Province, Mount Lipa, *Bur. Sci. 38545 Ramos and Edaño* (M).

Reproductive structures are represented, on the cotype which I have seen, by a single loose calyx, including a young fruit, in a pocket attached to the sheet. The Bukidnon specimen is of a very similar, perhaps more bristly plant; it has a single badly crushed fruit, black according to the field label, detached and preserved in a pocket. This was borne on a solitary bristly pedicel about 2 mm long.

This appears to be the closest among Philippine species to *D. soror*, *D. amboinensis*, and *D. consobrina*, of Beccari. This group is related to *D. rufa* Stapf and *D. chrysothrix* Stapf, but differs from them in having glabrous flower parts. The group represents, probably, an evolutionary transition leading to *D. parvifolia*, *D. microphylla*, and their allies, with small leaves and strictly solitary flowers.

8. DIPLYCOSIA PARVIFOLIA Merrill.

Diplycosia parvifolia MERRILL in Philip. Journ. Sci. 5 (1910) Bot. 211, Enum. Philip. Fl. Pl. 3 (1923) 247.

The original description reads:

Frutex parvus epiphyticus vix 1 m altus, ramulis junioribus plus minus setosis; foliis coriaceis, nitidis, ellipticis vel elliptico-oblongis, basi acutis, apice acutis vel leviter acuminatis, 1 ad 2.5 cm longis, subtus glanduloso-punctatis, nervis lateralibus obsoletis, basi interdum obscure triplineriis; floribus paucis, axillaribus, solitariis, pedicellatis, calycis segmentis minute ciliatis.

A small, epiphytic, erect shrub less than 1 m high, diffusely branched, the branches slender, glabrous, brown, slightly striate, terete, the branchlets with scattered slender, brown, more or less appressed, setose hairs. Leaves coriaceous, elliptic to elliptic-oblong, 1 to 2.5 cm long, 1 cm wide or less, entire, the base acute, the apex acute or slightly acuminate, glabrous and shining when dry, but the margins of the younger leaves more or less ciliate-setose, the lower surface with scattered, dark-colored, small glands; midrib distinct, the lateral nerves and reticulations obsolete, the base sometimes very obscurely triplinerved; petioles about 2 mm long, glabrous. Flowers axillary, solitary, few, their pedicels setose, up to 7 mm in length, the corolla unknown, basal bract minute, less than 1 mm long, the apex of the pedicel with two orbicular-ovate bracteoles about 1.5 mm in diameter. Calyx glabrous except the slightly ciliate margins of the lobes, accrescent, the lobes just after anthesis ovate, acuminate, about 2 mm long; style persistent, 2 mm long.

NEGROS, Canlaon Volcano, on mossy trunks in forests at an altitude of about 1,500 m, *Merrill 6995*, April, 1910.

A species well characterized by its comparatively small leaves, the lateral nerves obsolete except sometimes the very faint subbasal pair.

NEGROS, Canlaon Volcano, *Merrill 6995* (M; type). LUZON, Ifugao Subprovince, Mount Polis, *Bur. Sci. 19704 McGregor* (M).

The specimen from Mount Polis has leaves closely resembling those of the type but somewhat bristly beneath; the stems are more bristly than those of the type, and the pedicels shorter. The flowers remain unknown, but are probably indistinguishable from those of *D. luzonica* and *D. calelanensis*. The species is doubtless very close to *D. microphylla* Becc. Ridley has described two other species, *D. elliptica* and *D. cordifolia*, which inhabit the Malay Peninsula and belong close to *D. microphylla*.

9. DIPLYCOSIA sp. indet. Plate 5, fig. 3.

An epiphytic shrub with ovate-acute, thickly coriaceous leaves 3–5 cm long, lucid above, bristly beneath, 3-nerved but the lateral nerves nearly obsolete, margins entire; the fleshy black fruit-bearing calyces solitary or paired, on bristly pedicels about 8 mm long.

CATANDUANES, Mount Mariguidon, 277 m, *Bur. Sci. 30318 Ramos and Chan* (M, W), November 14, 1917.

The entire and coriaceous character of the leaves, and the fruits one or two in a cluster, seem to separate this from *D. luzonica.*

10. DIPLYCOSIA sp. indet.

Diplycosia luzonica ELMER in Leafl. Philip. Bot. 3 (1911) 1105, non Merrill.

Elmer gives the following:

Field-note:—Epiphytic shrub, upon the larger or lower limbs of trees at 8500 feet or near the summit of mount Calelan; stems 3 feet long, tough, branched especially above the middle, its bark smooth and brown; twigs chiefly ascending, brown or grayish, provided with brown hairs; leaves ascending, flat or only slightly recurved, shining dark green above, much paler beneath, the petiole and young foliage red; pedicels green or reddish, recurved; calyx green or the segment tips reddish brown; corolla 0.33 inch long, greenish, not tapering nor constricted toward the apex. 'Sagumati' is the Bagobo name.

Represented by number 11676, *Elmer*, Todaya (Mt. Apo), Mindanao, September, 1909.

The elliptic obtuse leaves about 3.5 cm long, on well-developed petioles, are essentially glabrous. The flowers are solitary or in pairs on glabrescent pedicels 6 to 8 mm long. The stamens, about 1.5 mm long, open through introrse slits 0.5 mm long, not by terminal pores nor by very brief subterminal slits. This character might justify the publication of a new species, but it is very obscure, and I have not seen enough material to be sure it is reliable.

Genus IAERA novum

Plantae lignosae, saepissime vel semper epiphyticae, ramulis juvenilibus interdum exceptis glabrae; folia alterna, integra, crassa, nervis subdigitatis adscendentibus, petiolis utroque latere conspicue uniglandulosis; flores solitarii vel fasciculati, axillares vel extra-axillares, pedicellis basi bracteatis (bracteis 2–6, minutis, decussatis), sub ovario non articulatis; calyx 5-partitus; corolla sympetala, minuta, alba, 5-partita; stamina 10; filamenta applanata, ciliolata (ciliolis paucis, applanatis), apice abrupte incurva; antherae dorsifixae; thecae muticae, dimidiis superioribus in tubulos attenuatis, per rimas breves subapicales introrsas dehiscentes; discus minutus stylum terete corollae subaequilongum subtendens; ovarium inferum 5-loculatum, ovulis c. 5 in quoque loculo, placentis axialibus; bacca parva, seminibus ovoideis foveolatis. Typus, Vaccinium lanaense *Merrill.* (Iaera: nomen cuiusdam oreadis.)

I can assign to *Iaera* only the three Philippine species listed below. These species have leathery leaves, with a single conspicuous gland on each side of the petiole; solitary or fascicled flowers with minute corollas; the pedicel not articulate to the ovary; filaments with a row of flattened trichomes along each edge; anthers attenuate, without horns; seeds few (about twenty-five) in the five-celled ovary; surface of the seeds, as seen under the dissecting lens, conspicuously pitted. For the present, I treat all the above characters as generic characters; one may expect the discovery of new species, obviously belonging to this genus, but with characters that will require the modification of the generic description.

The Formosan *Vaccinium merrillianum* Hayata appears to show similarities. Two Bornean plants, *V. uniflorum* J. J. Smith and *V. monanthum* Ridley, appear to be similar; but the original descriptions of these species fail to mention some of the characters that would permit me to decide whether they should be transferred.

Key to the species.

1. Leaves 5 cm long or longer.
    2. Pedicels scarcely 5 mm long, leaves ovate or lanceolate, usually acuminate .... 1. *I. lanaensis.*
    2. Pedicels over 1 cm long, leaves elliptic or obovate, obtuse or rounded .... 2. *I. lucida.*
1. Leaves scarcely 2 cm long, elliptic or obovate, obtuse or rounded. 3. *I. loheri.*

1. IAERA LANAENSIS (Merrill) comb. nov. Plate 6, figs. 1–6.

Vaccinium lanaense MERRILL in Philip. Journ. Sci. 3 (1908) Bot. 161, 372, Enum. Philip. Fl. Pl. 3 (1923) 250.

Vaccinium medinilloides ELMER in Leafl. Philip. Bot. 3 (1911) 1097.

The original description reads:

Arbor vel arbuscula, glabra, epiphytica; foliis coriaceis, ovatis vel oblongo-ovatis, 6 ad 11 cm longis, acuminatis, basi valde 5–7-nerviis; floribus axillaribus, fasciculatis, parvis, corolla ca. 2 mm longa, cylindrica, glabra; fructibus ovoideis, 4–5 mm diam.

An epiphytic shrub or tree, glabrous throughout, the branches light gray or pale brown, terete. Leaves ovate or oblong-ovate, rarely ovate-lanceolate, 6 to 7 cm long, 2 to 6 cm wide, coriaceous, shining, apex rather strongly acuminate, base rounded to subacute, the margins entire, somewhat revolute; nerves basal or subbasal, prominent, 5, sometimes with an additional submarginal pair, the interior pair leaving the midrib shortly above the base and extending nearly to the apex of the leaf, the reticulations obscure; petioles stout, about 3 mm long. Flowers in axillary 2- to 5-flowered fascicles, the pedicels, glabrous, 3 to 4 mm long, each subtended by a pair of small somewhat sheathing bracteoles. Calyx glabrous, 2 to 2.5 mm long, the limb short, somewhat spreading, the lobes broadly orbi-

cular-ovate, acute or acuminate, about 0.7 mm long. Corolla glabrous, cylindrical, short, 2.5 mm long or less, the teeth broadly ovate, about 1 mm long. Stamens 10; filaments 1.5 mm long or less, slightly hirsute, the anthers about 1.2 mm long. Style glabrous, deciduous, 2 mm long; stigma capitate. Fruit ovoid, glabrous, 4 to 5 mm in diameter.

MINDANAO, Lake Lanao, Camp Keithley, *Mrs. Clemens 431*, March and June, 1906, also without numbers, September–October, 1906, September, 1907, and October, 1907.

An epiphytic species, growing on *Ficus*, in leaf-characters, shape, size, texture, and venation, very close to *Vaccinium apoanum* Merr., but entirely different in floral characters, well distinguished by its small entirely glabrous flowers.

The original description of *Vaccinium medinilloides* reads:

An epiphyte; stems several in the clump, 1.5 m. long, rigid, branched, 2 cm. thick, covered with smooth gray bark; twigs greenish or brown in the dry state, the young portion finely sericeous, the slender free ends descending. Leaves very rigid, easily breaking with a snap, flat or the acuminate tips only recurved, darker green on the upper side, glabrous, dull green when dry, entire margins somewhat involute, the base of the larger ones rounded, obtuse in the others, ovately oblong or the smaller blades broadly lanceolate, 10 to 15 cm. long or much shorter, 3.5 to 5.5 cm. wide below the middle, alternatingly scattered along the branches; nerves conspicuous on both sides, the 3 lateral ones subparallel and arising from below the middle, the upper ones of these main lateral nerves arched and extending clear to the apex, reticulations visible from both sides but not conspicuous; petiole suberect, glabrous, stout, dark brown in the dry state, up to 7.5 mm long, with a pair of large lateral glands above the middle. Flowers not seen; fruits in small fascicles, axillary or from the axils or fallen leaves; pedicels strict, glabrate, 5 mm. long, spreading, subtended at the base by minutely imbricated bracts; green fruit globose, glabrous, 5 mm. in diameter, bearing the persistent 5-toothed calyx, 5-celled and about 30-seeded; seeds obscurely trigonous, dark brown, 1.5 mm. long, minutely pitted and usually glistening.

Type specimen 11310, *A. D. E. Elmer*, Todaya (Mt. Apo), District of Davao, Mindanao, August, 1909.

Upon limbs of large trees in a humid forested basin, near the Baruring river at 4000 feet. It has the facies of *Medinilla*, and is called 'Lumoos' by the Bagobos.

It falls under the same group with *V. apoanum Merr.* and *V. calelanum Elm.*, but is entirely distinct from either.

MINDANAO, Lanao Province, Camp Keithley, *Clemens 431* (M; type of *Vaccinium lanaense*), *Clemens 431a* (M), *Clemens s. n.* (M, 3 sheets, W, 2 sheets): Zamboanga Province, Sax River Mountains, *Merrill 8301, 8307* (M); Davao Province, Mount Apo, *Elmer 11310* (M, W; type of *Vaccinium medinilloides*). NEGROS, Negros Oriental Province, Cuernos Mountains, *Elmer 10103* (M). PANAY, Capiz Province, Mount Bulilao, *Bur. Sci. 35683 Martelino and Edaño* (M).

The type specimen was growing on the same tree as the type of *Rhododendron nortoniæ*. The flowers are always white, so far as the field labels give this information; the plant is always, so far as the labels tell, an epiphyte. The reported altitudes are from about 700 (Mount Bulilao) to about 1,300 meters (Mount Apo). This, unlike our numerous *Rhododendra* and *Vaccinia* inhabiting the mossy forest, is apparently a plant of the taller forest of lower altitudes, in which epiphytes are not easily collected.

2. IAERA LUCIDA (Merrill) comb. nov. Plate 6, figs. 7–9.

Diplycosia lucida MERRILL in Philip. Journ. Sci. 11 (1916) Bot. 28.
Vaccinium costeroides MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 248.

The original description reads:

Frutex scandens glaber, ramis ramulisque teretibus; foliis ellipticis, coriaceis, nitidis, usque ad 7 cm longis, apice obtusis vel rotundatis, basi acutis, margine revolutis, integris, nervis utrinque 2 vel 3, adscendentibus, distinctis; floribus axillaribus, binis, longe pedicellatis; fructibus ovoideis, in siccitate circiter 5 mm longis.

An entirely glabrous scandent shrub, the branches and branchlets slender, terete, pale or brownish, smooth. Leaves coriaceous, shining, elliptic, 5 to 7 cm long, 2.5 to 3.5 cm wide, the apex rounded or obtuse, base acute, margins entire, revolute; lateral nerves 2 or 3 on each side of the midrib, rather prominent, ascending, the reticulations lax; petioles about 7 mm long. Flowers in axillary pairs, their pedicels slender, about 1.5 cm long. Corolla glabrous, cylindric, about 3 mm long, the lobes 5, broadly ovate, 0.5 mm long. Stamens 10, the filaments 1.7 mm long, slightly pubescent; anthers about 1 mm long. Fruit black when dry, obovoid, about 5 mm long, the persistent calyx teeth broad, short, apiculate.

LUZON, Province of Sorsogon, Mount Kililibong, *Bur. Sci. 23504 Ramos*, August 17, 1915, on trees at the summit, apparently at an altitude of about 1,000 meters.

A species well characterized by being entirely glabrous, by its obtuse or rounded leaves with revolute margins, and by its axillary pairs of long-pedicelled flowers. It somewhat resembles *Diplycosia baclayanensis* Elm., but differs in its leaf characters and in its long pedicels.

Known only by the type collection (M, W). The words of the field label, as to habitat, are "on tree summit," apparently meaning that the plant was an epiphyte on the summit of the mountain. The color of the flowers is not noted. The slender style, with a club-shaped apex, is about 2.5 mm long. The brownish pitted seeds, about 26 in the fruit, are about 1.5 mm long.

3. IAERA LOHERI (Merrill) comb. nov. Plate 7, figs. 1–5.

Vaccinium loheri MERRILL in Philip. Journ. Sci. 7 (1912) Bot. 323, Enum. Philip. Fl. Pl. 3 (1923) 250.

The original description reads:

Frutex parvus, epiphyticus, glaber; foliis crasse coriaceis, ellipticis, in siccitate pallidis, nitidis, 1.5 ad 2 cm longis, integris, apice rotundatis, basi obscure triplinerviis, acutis, 2-glandulosis, petiolo vix 2 mm longo; floribus solitariis, axillaribus, pedicellatis.

A small epiphytic, glabrous shrub, the branches terete, grayish, the younger ones reddish brown, wrinkled when dry. Leaves numerous crowded, elliptic, 1.5 to 2 cm long, thickly coriaceous, when dry rather pale and shining, the apex rounded, the base acute, with two prominent glands near the juncture with the petiole, the margins thickened, somewhat recurved, base obscurely 3-plinerved, the lateral nerves nearly as prominent as the midrib, nearly or quite reaching the apex, the reticulations obsolete or nearly so; petioles 1 to 2 mm long. Flowers white, according to the collector (corolla not seen). Pedicels solitary, axillary, slender, about 6 mm long, somewhat curved, the basal bracteoles ovate, about 0.5 mm long. Calyx 2 mm long, broadly urceolate, the tube ovoid, globose, about 1.5 mm in diameter, the limb somewhat spreading, 5-toothed, the teeth broadly triangular-ovate, acute or slightly acuminate, 0.5 mm long.

LUZON, Province of Rizal, Montalban; that is, in the mountains back of Montalban, *Loher 6187*, April 18, 1905.

Although my specimen is imperfect, the corolla being lacking, I have not hesitated to describe this distinct form. It is well characterized by its small, crowded, entire, obtuse, obscurely nerved leaves which are rounded at the apex, acute and 2-glandular at the base, and by its solitary, axillary flowers. Among Philippine species it is most closely allied to *Vaccinium microphyllum* Blume (*V. mindorense* Rendle), but is very different from that species.

LUZON, Rizal Province, Montalban, *Loher 6187* (M, W; type), *Loher 13248* (M, C).

Loher usually neglected the taking of any field notes; he made a useful exception in the case of the type sheet of this species, on the label of which one reads, in his hand, "Fl. alb. epiphytic." On his second collection cited above, flowers in bud were found. The stamens, which, in the buds observed, were about 1.2 mm long, have exactly the structure of those of the other species of *Iaera*. The fruit is about 3 mm in diameter, the pitted seeds about 1.2 mm long.

Genus DIMORPHANTHERA F. von Mueller

The eminent Baron Ferdinand von Mueller was a man of great industry, and became an object of admiration and envy to the other botanists of the world. But living away from personal contact with his fellow botanists, he committed, occasionally, annoying breaches of phytographic good form. He was able to write fluently in Latin, but frequently described new groups in English. In one passage he managed to identify

a certain specimen as *Rhododendron lowii*, and at the same time to describe it as a new species, *R. megalostigma*. The name *Dimorphanthera*, credited to him as a generic name, first appears[19] in a specific description under the following heading:

AGAPETES MOORHOUSIANA.

(DIMORPHANTHERA MOORHOUSIANA.)

The discussion following the description proper includes the following passage:

> Biformous anthers are not on record among Vaccinieae, except in Agapetes amblyornidis and A. meliphagidum, concerning which Dr. Beccari noted (Malesia I, 208 and 209) similarly dimorphous stamens, attributing however two contiguous cells to smaller anthers of those plants. I have therefore left this new species though reluctantly in the genus Agapetes, as the fruit also remains unknown. Nevertheless it would be best, to separate these three Papuan plants under the generic appellation Dimorphanthera. The five shorter one-celled anthers of our plant resemble much those of the Andine genus Macleania, which likewise has the calyx-limb undivided. From D. amblyornidis our plant differs specifically in much shorter petioles, smaller leaves and flowers, and further in the calyces not being denticulated, probably also in the fruit. From D. meliphagidum ours is more distinct, thus it has neither the prolongation of the connective of the anthers. Dr. Beccari mentions that these kinds of plants are much frequented by honey-sucking birds.

In the same year he referred another new species, *Agapetes forbesii*,[20] to *Dimorphanthera*, treating this quite definitely as a subgeneric group. He appears first definitely to have used *Dimorphanthera* as a generic name in 1890,[21] when *D. forbesii* was included in a list of recently described plants from New Guinea, without description. Warburg[22] used *Dimorphanthera* as a generic name; Drude[23] treated the group as a subgenus of *Agapetes*, and furnished, for the first time, a formal description; of the four species then known, he recognized only two, *A. forbesii* and *A. meliphagidium*. Koorders[24] followed Drude in including these plants in *Agapetes*. J. J. Smith, in several works, and Schlechter,[25] give the group the generic rank which, in my opinion, is proper.

[19] In Wing's Southern Science Record n. s. 2 (February, 1886). I have not seen the original, but the reprint in Bot. Centralbl. 26 (1886) 163.

[20] In Journ. of Bot. 24 (October 1886) 290.

[21] Descr. Notes Papuan Pl. 9 (1890) 63.

[22] Engler's Bot. Jahrb. 18 (1894) 203.

[23] Natürl. Pflanzenfam. 4:1 (1891) 55.

[24] In Nova Guinea 8 (1912) 885 et seq.

[25] In Engler's Bot. Jahrb. 55 (1918) 184.

This history illustrates the fact that irrespective of rules to the contrary, genera may be established without ever being formally raised to that rank and without being described, if they are duly typified and if botanists in general become aware of them and accept them. The type is definitely *Dimorphanthera moorhousiana,* because it was in connection with that species that the name was first used; this is true in spite of the fact that the first combination unequivocally made under the generic name was *Dimorphanthera forbesii,* and likewise in spite of the fact that *Agapetes moorhousiana* was overlooked in Drude's first formal description of the group. The recognition of the type becomes important in determining the application of sectional names.

Schlechter, in his treatment of the group in 1918, commented on the remarkable increase in number of known species that had occurred in the previous few years. He recognized twenty-seven species, all except one in New Guinea, the exception in the Philippines. Since Schlechter's work, only one new species, *D. mindanaensis* Merrill, has been described; but the number must be increased by several which Schlechter overlooked, namely *D. pulchra* J. J. Smith, in Amboina, and three species described by Wernham [26] from the collections of the Wollaston Expedition to Dutch New Guinea. One species is to be subtracted in view of J. J. Smith's reduction [27] of *D. d'Armandvillei* to *D. wrightiana;* this leaves a total of thirty-one species, with a possible thirty-second to be mentioned below.

The genus was first divided into sections by Wernham, who separated two species with longitudinally ribbed calyces, as in *Pentapterygium,* to form a section *Pteridosiphon.* Only these two species are positively known as belonging to the section; a possible third species, and thirty-second of the genus, is *Agapetes costata* Wright, of British New Guinea. J. J. Smith [28] remarked that the original description leaves it uncertain whether this species is to be transferred to *Vaccinium* or to *Dimorphanthera;* the description does, however, emphasize the ribbed character of the calyx.

Wernham referred all the rest of the species to a section *Cyclosiphon,* the type of which section is evidently the type of

[26] In Trans. Linn. Soc. Bot. 9 (1916) 89--90.
[27] In Nova Guinea 12 (1917) 516.
[28] Op. cit. 520.

the genus. Two years later Schlechter, in ignorance of Wernham's work, and of the existence of anything of the *Pteridosiphon* type, divided the genus into two sections: *Brachycone,* with campanulate corollas generally less than 2 cm long, and *Trochilanthe,* with tubular corollas generally over 2 cm long. These are apparently natural groups, and are accordingly to be maintained; but as *Cyclosiphon* is an older name for the type section, this name is to replace *Brachycone* Schlechter as the name of the section including *D. moorhousiana.*

Section *Cyclosiphon* includes twelve species, among which are all of the three known from outside of new Guinea; although these—*D. pulchra* and the two Philippine species—have the flowers in axillary fascicles instead of in racemes, as do at least many of the New Guinean species. Section *Trochilanthe,* of which *D. amblyornidis* (Beccari) F. von Mueller may be regarded as the type, includes seventeen species.

Key to the Philippine species.

1. Corolla externally pubescent .... 1. *D. apoana.*
1. Corolla externally glabrous .... 2. *D. mindanaensis.*

1. DIMORPHANTHERA APOANA (Merrill) Schlechter. Plate 7, figs. 6-7; 8, figs. 1-4.

Dimorphanthera apoana (MERRILL) SCHLECHTER in Engler's Bot. Jahrb. 55 (1918) 185; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 252.
Vaccinium apoanum MERRILL in Govt. Lab. Publ. (Philip.) 29 (1905) 39, Philip. Journ. Sci. 3 (1908) Bot. 372; ELMER in Leafl. Philip. Bot. 3 (1911) 1091.
Vaccinium calelanum ELMER in Leafl. Philip. Bot. 3 (1911) 1096.

The original description, under *Vaccinium,* reads:

A tree reaching a height of 10 m. with elliptical-oblong, sharply acuminate leaves, the flowers in axillary bracteate fascicles of from 3 to 6 in a fascicle. Branches reddish brown, glabrous. Leaves 7 to 11 cm. long, 3.5 to 6 cm. wide, glabrous, coriaceous, the base acute, 5 to 7 nerved from near the base, the outer pair of nerves obscure, the inner ones very prominent, especially beneath, sharply ascending; petioles 1 cm. long. Fascicles axillary, the peduncles glabrous, 1 cm. long, the bracts imbricate, ovate, rusty pubescent on the outside. Calyx cylindrical, 4 mm. long, 3 mm. in diameter, truncate, glabrous, the teeth small. Corolla 13 mm. long, pubescent, tubular-campanulate, the lobes about 3 mm long, rounded, reflexed. Stamens 10, the filaments thick, 2.5 mm. long, the anthers 3 to 4 mm. long. Fruit unknown.

Type specimen No. 1103 (Copeland), Mount Apo, District of Davao, Mindanao, April, 1904. A tree reaching a height of 10 m. and a diameter of 30 cm., the wood white. The vegetative characters are very similar to those of *Vaccinium barandanum* Vidal.

Elmer gives the following field note, with regard to a specimen identified as *Vaccinium apoanum:*

An epiphytic shrub, on the upper rigid limbs of trees on a wind swept ridge at 3,500 feet of mount Burebid; stems numerous from the same root cluster, ascending and interlaced, forming dense bushes, 6 feet high, the larger ones 1.5 inch thick and freely rebranched, wood watery white, not hard, sweetish, odorless; bark brown, on the stems thinly checked, smooth on the more or less slender and numerous branchlets; leaves rigid, flat, ascending, paler green beneath; flowers deep flesh red, pendulous, upon strongly recurved green pedicels, odorless. The Bagobos call it 'Tahima.'

Represented by number 11258, *Elmer*, Todaya (Mt. Apo), Mindanao, August, 1909.

These specimens are typical and are always epiphytic shrubs, never trees 20 feet high with stems a foot thick.

The original description of *Vaccinium calelanum* reads:

Epiphytic; stems usually several, 2 m. long, inclined to creep or sprawl, rigid, only sparingly branched, its gray bark usually checked, the twigs brownish and puberulent. Leaves alternate or indefinitely whorled at the basal portion of the relatively short and gnarly branchlets, ascending, rigid, with recurved acute or acuminate tips, shining deep green on the upper side, much paler green and sprinkled with glands on the lower surface, otherwise glabrous, rounded or subtruncate at the base, exceedingly variable in size, entire, characteristically brown in the dry state, the larger blades 8 dm. [cm] long and 4 cm. wide below the middle, frequently much smaller and occasionally larger, ovately oblong, the smaller ones distinctly ovate with a slender tip; petiole thick, dark brown, puberulent, 5 mm. long; midrib conspicuous beneath especially toward the base, with 2 lateral pairs arising from near the base, the upper lateral pair stronger and curvingly arched clear into the apex, reticulations none. Inflorescence sessile, clustered, axillary; the subtending bracts large, rigid, imbricate, broadly rounded or rotund, the basal ones much reduced and subglabrous except the ciliate margins, the other short but densely ferruginous pubescent; bracteoles 2, subtending the pedicels or attached to them at the base, ovate in outline, 3 mm. long, the acute apex ciliate, the lateral margins brown winged; pedicels stout, at most 1 cm. long, glabrate, usually recurved; calyx glabrous, 5 mm. long or shorter, cupshaped, truncate at the base, more or less angular even in the dry state, dark green. bearing 5 short and broad teeth; buds short yellowish gray pubescent, oblong; corolla deep red, turbinate, 12.5 mm. long, with 5 short obtuse or longer and acute teeth, veiny; stamens 10, inserted upon the base of the corolla and falling with it; filaments flattened the whole length, 3 mm. long, glabrous or only sparsely strigose on the outer side toward the top, anthers beakless or with only very short ones, 4 mm. long, oblong, dorsally attached toward the base, the blunt basal portion inwardly curved, the upper one half divided, dehiscent through large longitudinal slits on the ventral side; style smooth, nearly 15 mm. long, terete, reddish, terminated by a small red stigma; ovary inferior; fruit not seen.

Type specimen 11345, *A. D. E. Elmer*, Todaya (Mt. Apo), District of Davao, Mindanao, August, 1909.

Collected on small trees scattered among interlaced shrubs in the mossy woods at 7,750 feet of mount Calelan. The Bagobos call it 'Calumping.'

A critical segregate from *V. apoanum Merr.*, but the leaves differently shaped, calyx distinctly toothed and with other minor floral characters. The ripe fruits for both of them are unknown.

In transferring the species to *Dimorphanthera,* Schlechter remarks merely that "die einzige bisher ausserpapuasische Art ist *Dimorphanthera apoana* (Merr.) Schltr. (*Vaccinium apoanum* Merr.), eine Pflanze der Gebirgswälder auf der Insel Negros von den Philippinen," and that the species belongs to his section *Brachycone.*

MINDANAO, Davao Province, Mount Apo, *Copeland 1105* (M, W, type), *Williams 2550* (M, W), *Elmer 11258* (M, W), *Clemens 15681* (C); Mount Calelan, *Elmer 11435* (W, type of *Vaccinium calelanum*): Bukidnon Province, Mount Candoön, *Bur. Sci. 38914 Ramos and Edaño* (M, W). NEGROS, Mount Silay, *Whitford 1497* (M, W); Canlaon Volcano, *Merrill Philippine Plants 224* (M, W). PANAY, Antique Province, *Yoder s. n.* (M).

At altitudes from 1,200 to 2,600 meters, both extremes collected by Elmer in the Mount Apo region.

The character of all the non-Philippine species, and the positive statements of Elmer, cast doubt upon the observation of E. B. Copeland, who wrote on the field label of the type specimen "Tree 35 ft. high, 1 ft. in diam. Wood white." Williams's succinct note reads "1 in x 15 ft." Whitford wrote "vine?"; Merrill, "Epiphytic shrub 2–3 m." The remaining collections are without notes as to habit. If all of these notes are correct, a greater variability than is usual even in shrubs of the mossy forest is indicated.

The stems are glabrous, except in *Elmer 11435*, and it is possible that *V. calelanum* will sometime be found tenable, as a species, by this character. The petioles are pubescent in about half of the collections, glabrous in the others; they are stout, terete, rather less than 1 cm long. The somewhat coriaceous, entire, usually acuminate, leaves vary greatly in size and to some extent in shape and in the number of the main palmate nerves. The upper surface is glabrous, the lower sometimes punctate, sometimes with scattered apparently glandular hairs, sometimes glabrous; *V. calelanum* cannot be distnguished by leaf characters. Merrill and Elmer have mentioned the suborbicular imbricate bracts less than 1 cm long that surround the flower clusters, and Elmer has described the paired bracteoles on the bases of the glabrous pedicels. The calyx teeth are al-

ways distinguishable, rounded, with a brief apiculation. The campanulate pubescent red corolla is 9 to 13 mm long; the lobes are briefly acuminate and become reflexed in age, while the style becomes exserted. The filaments are 1 to 2 mm long, separate, flattened, with a few hairs on the backs and margins. The oval small anthers, 2 to 3 mm long, are strongly projected forward at the base; each bears on the back, as upward projections of the connective, two obscure horns which do not reach the summit of the tubes. The larger anthers, of the shape well described by Schlechter as obsagittate, are about 3.5 mm long; each bears on the back of each tube a flattened ascending scale reaching as far as the summit of the tube. The disk is prominent; the ovary is strictly 5-celled; the axile placentæ, bearing very numerous ovules, project strongly into the cells. The Manila specimen of *Williams 2250* was found to bear a cluster of three apparently mature fruits; these were borne on pedicels that had become thicker but not much longer than when in flower, and were apparently black and fleshy, 9 mm in diameter crowned by the disk 3 mm in diameter and the 5-toothed calyx limb 6 mm in diameter. The elongate seeds are about 1 mm long, brown, with a very finely striate or reticulate surface.

2. **DIMORPHANTHERA MINDANAENSIS Merrill.**

Dimorphanthera mindanaensis MERRILL in Philip. Journ. Sci. 20 (1922) 418, Enum. Philip. Fl. Pl. 3 (1923) 252.

The original description reads:

Species D. apoanae Schltr. affinis differt floribus glabris.

A shrub, entirely glabrous except the bracts enclosing the inflorescences, the branches and branchlets rather stout, reddish brown when dry or sometimes nearly black. Leaves thickly coriaceous, ovate to elliptic, brownish when dry, 4 to 8 cm long, 2.5 to 4.5 cm wide, somewhat shining, the apex shortly acuminate, the base acute to rounded and usually 5-nerved, sometimes with an additional pair of slender marginal nerves, the inner nerves leaving the midrib 4 to 8 mm above the base, the reticulations rather lax; petioles 4 to 8 mm long, rather stout. Flowers fascicled in the uppermost axils, the young buds entirely enclosed by numerous, imbricate, brown, sparingly pubescent, concave bracts forming a cylindrical head about 1 cm in diameter, some of the bracts subpersistent, others deciduous. Pedicels up to 10 mm long. Calyx glabrous, about 3.5 mm long, shallowly 5-lobed, the lobes broadly ovate, shortly and abruptly acuminate. Corolla red, 8 to 10 mm long, glabrous, somewhat widened upward, the lobes ovate, about 3 mm long. Stamens 10, glabrous, dimorphous, the larger ones with filaments and anthers about 4 mm long, the shorter ones with filaments 3 mm long and anthers about 2 mm long. Styles 12 mm long, glabrous. Fruits unknown.

MINDANAO, Misamis Province, Mount Malindang, *For. Bur. 4708 Mearns and Hutchinson*, May, 1906. In the mossy forest, altitude about 1,700

meters. The same species is apparently represented by *Bur. Sci. 38537 Ramos and Edaño* from Mount Lipa, Bukidnon Subprovince, Mindanao, July, 1920.

Both specimens were originally identified as *Vaccinium apoanum* Merr. = *Dimorphanthera apoana* Schltr. but, like that species, are true representatives of the genus *Dimorphanthera*, differing from the latter especially in the glabrous flowers. It is the second species of the genus to be found in the Philippines, *Dimorphanthera* being now known otherwise only from New Guinea and Amboina, with twenty-seven species in New Guinea and one in Amboina.

This species is known only by the two collections cited in the original description, and these are represented, apparently, only in the herbarium of the Bureau of Science at Manila. Although distinguished only by a single character of moderate weight, the species may be maintained, at least for the present.

GENERAL REMARKS

It is of the nature of modern science, and conspicuously true of taxonomy, that the published statement of any particular piece of work is in a sense preliminary, a progress report, a contribution; never a full and final statement of the truth on its subject. The present work should lead both to a more intensive study of the Philippine Ericaceæ, and to a more extensive study of Ericaceæ in general. As to the Philippine plants, the problems here solved appear to be fewer than those revealed as not yet soluble. As to Ericaceæ in general, any advance in knowledge is certain to be reflected in a better understanding of the Philippine representatives of the family. This applies especially to the family as represented in the Malay region, because most of the Philippine plants have come from the south, at least in the sense that their ancestors lived there. A summary of existing knowledge and opinion, with regard to the taxonomy of Ericaceæ in general, and in the Malay region in particular, may form an appropriate conclusion to the present work.

THE CLASSIFICATION AND RELATIONSHIPS OF THE ERICACEÆ

My studies of the Ericaceæ, based both on material and on the literature, have been confined to gross morphology, and the remarks about to be presented lack the valuable foundation and the completeness in detail to be obtained by studies of minute anatomy and of ontogeny.

The family was satisfactorily arranged by Drude, in the Natürlichen Pflanzenfamilien (1891), in four subfamilies; the first three with the corolla deciduous, not papery.

1. Rhododendroideæ: ovary superior; fruit a septicidal capsule.

2. Arbutoideæ: ovary superior; fruit a capsule, not septicidal, or a berry.

3. Vaccinoideæ: ovary inferior; fruit a berry.

The fourth subfamily, in which the papery corolla is persistent after flowering, is—

4. Ericoideæ: ovary superior, fruit variable. Of this group, the geographic distribution of which is comparatively limited, I shall have no more to say.

There is no doubt that these groups are closely related to one another, and to the families Pyrolaceæ and Clethraceæ. Likewise, if carpels are homologous with leaves, it cannot be doubted that the Rhododendroideæ, in which the carpels finally separate practically as units, and some of which, furthermore, have separate petals, are the most primitive members of the alliance.

Where have the Ericaceæ been placed in systems of classification? In treating the Sympetalæ, the earlier authors, such as the de Candolles, Gray, and Bentham and Hooker, named first the Inferæ, culminating in the Compositæ and other Campanulatæ; then the Ericales, with the Vaccinioideæ first; then the Myrsinaceæ, the Primulaceæ, and the rest of the Sympetalæ. I think I do these authors no injustice in understanding this arrangement as implying the belief that the Ericales represent a transition from the Sympetalæ with inferior ovaries to those with superior ovaries. This view has long since been abandoned.

Eichler, and Engler and Prantl, placed the Ericales first among the orders of Sympetalæ. This treatment gives no hint of any hypothesis as to the origin of the group; there is certainly no implication of derivation from Umbellifloræ. On the other hand, I gather the implication that the Ericales are close to Primulales, and more or less representative of the ancestors of all the Sympetalæ. Any such disposition is, I am convinced, to be abandoned; Primulaceæ appear to be an offshoot of Centrospermæ; the Ericales are the highly developed end of some other line, and have given rise to no further developments.

As a guide in the search for ancestors to the Ericaceæ, we make up a hypothetical description, chiefly from the characters of the Rhododendroideæ. Such a description reads about as follows: Woody plants, with simple leaves, beset with trichomes; flowers with the parts in sets of five or more, polypetalous; stamens twice as many as the petals or even more numerous; an-

thers opening by terminal pores; disk present; ovules numerous on axile placentæ; fruit a septicidal capsule.

Saurauia, a genus widespread and numerous in species, comes very close to perfect agreement with this hypothetical description. The connection between *Saurauia* and the Ericaceæ seems first to have been noticed by Lindley,[29] who wrote:

> The genus Saurauja is usually stationed among Theads (Ternstroemiaceae), from which its minute embryo, indefinite seeds, and very copious albumen remove it. From Dilleniads it differs in the want of an aril, and in little else that can be regarded as essential; for its styles, which are divided to the very base, afford conclusive evidence as to its having a tendency to disunite its carpels. If it were not for that circumstance, and its indefinite stamens, it might be placed among Heathworts, of which it has the embryo, the minute indefinite seeds, a tendency to form a monopetalous corolla, and anthers opening by pores. I can scarcely doubt that it forms a complete transition from the Ranal to the Erical Alliance.

This view was noticed with interest by de Vriese,[30] and was applied in classification by Hallier.

Various hints support the view that the resemblance between *Saurauia* and the Ericaceæ is a mark of relationship. In *Saurauia* and the closely related genus *Clematoclethra* the stamens in bud are arched outward so that the anthers are borne in an inverted position; at anthesis, the anthers turn right side up. Exactly the same thing happens with stamens of remarkably similar appearance in Pyrolaceæ and Clethraceæ. Certain mistakes of the past may be mentioned. The name *Clematoclethra* reminds us that this group was described by Franchet as a section of *Clethra*. *Mischopleura*, described by Wernham as a new genus of Ericaceæ, ceases to be a puzzle when assigned to the neighborhood of the great dilleniaceous genus *Hibbertia*. Such evidence cannot be pressed too far; from von Mueller's description of a melastomaceous plant as a new genus (*Catanthera*) in Vaccinioideæ, one can derive nothing except a suggestion of parallel evolution.

Granting the connection of Ericaceæ to Dilleniaceæ, the ancestry of the family is traced back as far as that of any family of dicotyledons. The genus *Dillenia* is presumed to be a primitive group, close to *Magnolia* and of about the same evolutionary stage as *Alisma*. The more or less continuous evolutionary series from *Dillenia* to *Actinidia*, *Saurauia*, and *Clematoclethra*

[29] Vegetable Kingdom (1846) 423.
[30] Pl. Ind. Bot. Or. (1856) 34.

covers a range of evolutionary stages much broader than the gap between the latter genera and the Ericales.

ERICACEÆ OF THE MALAY REGION: GEOGRAPHIC AND HISTORICAL SUMMARY

Ericaceæ inhabiting the Malay region were first described by W. Jack, who, in 1822, published his Malay Miscellany, in Bencoelen, a region of southwestern Sumatra. I have not seen this work, which is apparently very rare; three articles by Jack in Hooker's Botanical Miscellany and Journal of Botany are reprinted from it. Here two species of Ericaceæ are described:[31] *Rhododendron malayanum* and *Vaccinium sumatranum*. These were collected "on the very summit of Gunong Bunko, a remarkably insulated mountain in the interior of Bencoolen, commonly called by Europeans the Sugar-loaf, in reference to its shape. Its elevation is estimated not to exceed three thousand feet . . ." *Rhododendron malayanum* is a widely distributed and well known species; on the other hand, I have found no reference to any subsequent collection of *Vaccinium sumatranum:* this name will probably be found to replace one now more familiar.

In 1826, Blume, in his Bijdragen, treated the Ericaceæ, chiefly of Java and Celebes. He described twenty-one species, including representatives of all of the three subfamilies in which the Ericaceæ of the Malay region are now included. He included all of the native Rhododendroideæ (that is, all those described in the Bijdragen, with the exception of several cultivated species from China and Japan) in a new genus, *Vireya;* three of his six Arbutoideæ in a new genus, *Diplycosia;* and all except two of his Vaccinioideæ in *Thibaudia,* a genus otherwise reported only from South America.

From support of the proposition that most of the Ericaceæ of the Malay region belong to genera unknown in Europe and Asia, Blume began to retire in his Flora Javæ, where, in a footnote,[32] he reduced *Vireya* to *Azalea* and *Rhododendron,* but did not make the new combinations. These were made by Hasskarl,[33] who also transferred all of Blume's *Diplycosiæ* to *Gaultheria.* Hasskarl, and Miquel,[34] the next great worker in the

[31] Hooker's Journ. Bot. 1 (1834) 369.

[32] 1 (1828) introd. vii.

[33] Cat. Pl. Bog. (1844) 160–162.

[34] Fl. Ind. Bot. 2 (1858–9) 1053 et seq. Ann. Mus. Bot. Lugd. Bat. 1 (1863) 36 et seq.

field of botany in the Malay region, described a few new species; thirty-one were listed in Miquel's final work. Since 1863, changes in the list of Ericaceæ known from Java, Celebes, Sumatra, and Dutch Borneo have been few and incidental. In 1914 the Ericaceæ of Java were revised by J. J. Smith,[35] who recognized twenty-three species on this island; and in 1925 a contribution by Hochreutiner [36] appeared. It is apparent from these works that several taxonomic problems, with regard to the Ericaceæ of Java, remain to be solved. The most important changes since 1863 have been the restoration of the genus *Diplycosia* and the description of *Costera*.

As early as 1848, Lindley [37] described four species of *Rhododendron* collected by Low in Sarawak. A few years later, after the first visit of white men to Mount Kinabalu, the younger Hooker was roused to such expressions of surprise as the following:

> Mr. Low's discovery of thirteen species of *Rhododendron*, during an ascent of only 8,000 feet on a mountain that rises to 14,000, is a most remarkable and interesting fact to the botanist and horticulturist. Till within a few years this genus had been thought almost peculiar to temperate and cold climates, an error first disproved by Mr. Low [overlooking Jack and Blume], and exposed by Dr. Lindley in the Hort. Soc. Journal, vol. iii, p. 82, where Bornean species are figured from under the equator itself, and growing at the level of the sea.[38]
>
> When we first received *Rhododendrons* from Borneo, we regarded the island whence they came as partaking, in respect of this genus, the characteristics of the north temperate zone; but now that species not only multiply in extraordinary profusion, but are found to frequent all elevations and all localities from the sea-coast inland, we are bound to reverse this, and consider that the Malay Archipelago is the head-quarters of the genus, and all other species outlying ones.[39]

The subsequent explorations of Haviland, as well as of more recent travellers, have increased but slightly the number of *Rhododendra* known from British North Borneo; they have, however, revealed the presence on Mount Kinabalu of fourteen species of *Diplycosia*, about one-third of the total number in the genus, as well as of a good representation of *Vaccinium*. Beccari and more recent explorers have added greatly to the number of Ericaceæ known from Sarawak.

[35] In Meded. Dept. Landbouw 18 (1814) 88–189.
[36] In Candollea 2 (1925) 490–502.
[37] Journ. Hort. Soc. Lond. 3 (1848) 81–91.
[38] Ic. Pl. (1852) t. 883.
[39] Op. cit. t. 890.

From the Malay Peninsula, eight scattered species were included by Clarke in Hooker's Flora of British India (1882). King and Gamble (1905), and Ridley, in a long series of papers, have added greatly to the list.

The history of our knowledge of Philippine Ericaceæ is discussed in connection with the various genera there occurring. Most of the Ericaceæ known from these islands before the American occupation were described by Sebastian Vidal. Most of the great increase beginning in 1905 is due to the work of Merrill, although one should not fail to mention the contributions of Warburg (1905) and Elmer (1911). The Philippine Ericaceæ are not now well known in comparison with the representatives of any important family of seed plants in any part of Europe or the United States. Nevertheless, the flora of the Philippines, as of Java and of the Malay Peninsula, is well known for an Oriental, tropical country.

This is not equally true of northern Borneo. Our knowledge of the Ericaceæ of Dutch Borneo, Sumatra, Celebes, and the Moluccas is very fragmentary.

The earliest account of the highland flora of British New Guinea was published by von Mueller [40] in 1889. Twelve Ericaceæ were described. Ten years later, Wright,[41] described four more; there has been only a slight scattering of other contributions.

The flora of northeastern (formerly German) New Guinea has been extensively studied. Ericaceæ were first described by Warburg,[42] who introduced four new *Rhododendra*. Schumann and Lauterbach (1901) added a few species. In 1917 and 1918, Schlechter [43] published no less than forty-seven new species, a greater number than had previously been known. His paper is a valuable contribution to classification, as well as to phytography.

Ericaceæ were first reported from Dutch New Guinea by Beccari (1878). None were added until 1909, when Koorders described a few. In the next decade a truly surprising number of species were distinguished; mostly by J. J. Smith, who published on this family in several fascicles of Nova Guinea; also by Wernham.[44] Nevertheless, the Ericaceæ of Dutch New Guinea

[40] Trans. Roy. Soc. Vict. 1, part 2.
[41] Kew Bull. (1899) 102–104.
[42] Engler's Bot. Jahrb. 16 (1893) 24–27.
[43] Engler's Bot. Jahrb. 55 (1917) 137–144, (1918) 145–194.
[44] Trans. Linn. Soc. Bot. 9 (1916) 89–100.

cannot be regarded as well known, since, according to the published records, a large majority of the species are known only by single collections.

Ericaceæ are poorly represented in Australia. This continent is mentioned because three species in Queensland are evidently outposts of the vegetation of New Guinea. A *Gaultheria* in Victoria belongs to the Antarctic flora. *Wittsteinia,* with a single species in Victoria, remains, as when von Mueller first described it, a genus incertæ sedis.

Ericaceæ are represented on the scattered islands of the Pacific by *Paphia,* which, although first described from Fiji, must be regarded as primarily a New Guinean genus; and by a number of species of *Vaccinium,* all of which are assigned to a single section, *Macropelma.* The relationships of *Macropelma,* whether with plants of the west, south, or east, remain very doubtful.

THE GENERA OF MALAYAN ERICACEÆ

The following is a key to the ericaceous genera recognized in the regions just discussed.

1. Ovary superior; disk surrounding the base of the ovary.
  2. Fruit not a septicidal capsule (subfamily Rhododendroideæ). 1. *Rhododendron.*
  2. Fruit not a septicidal capsule (subfamily Arbutoideæ).
    3. Fruit proper not a berry.
      4. Fruit a loculicidal capsule, not inclosed in the calyx; bracteoles absent; appendages present at the summits of the filaments, absent on the anthers .... 2. *Xolisma.*
      4. Fruit inclosed in the accrescent calyx; calyx usually subtended by two bracteoles.
        5. Fruit a loculicidal capsule; flowers often in racemes; almost always with four terminal horns on each anther. 3. *Gaultheria.*
        5. Fruit an irregularly shattering capsule; flowers axillary, solitary or fascicled; each anther with two terminal appendages or none .... 4. *Diplycosia.*
    3. Fruit proper a berry; calyx subtended by two or three bracteoles; anthers with two long tubes .... 5. *Pernettyopsis.*
1. Ovary more or less inferior (subfamily Vaccinioideæ).
  2. Disk massive, belting the ovary, which is at least half superior. 6. *Disiphon.*
  2. Disk crowning the ovary, which is usually fully inferior.
    3. Anthers dehiscing by terminal pores.
      4. Ovary attenuate into the pedicel, with no visible articulation; flowers minute.
        5. Stamens ten; petals united .... 7. *Iaera.*
        5. Stamens five; petals separate .... 8. *Costera.*

4. Ovary definitely articulated to the pedicel.
   5. Flowers under 1 cm long, or if longer, in racemes in which the rhachis is much longer than the pedicels and not much stouter. 9. *Vaccinium*.
   5. Flowers over 1 cm long (occasionally slightly shorter), solitary, fascicled, or in short racemes in which the rhachis is not much longer but is much stouter than the pedicels.
      6. Anthers all alike.
         7. Ovary without five conspicuous lengthwise wings.
            8. Plants of the region west of Java............ 10. *Agapetes*.
            8. Plants of the region east of Celebes................ 11. *Paphia*.
         7. Ovary with five conspicuous lengthwise wings. 12. *Pentapterygium*.
      6. Anthers of two kinds, five large ones alternating with five small ones .... 13. *Dimorphanthera*.
3. Anthers dehiscing by longitudinal slits .... 14. *Wittsteinia*.

Rhododendron Linn., Sp. Pl. (1753) 329. Type, *R. ferrugineum* Linn., of the Alps. Of the very numerous species, about half are native in western China, where the individuals appear to vary as do individuals of *Crataegus* in northeastern North America. In the Malay region, there are known more representatives of this genus than of any other in the family. The conspicuous flowers attract collectors who might overlook a *Vaccinium* or *Diplycosia*, and *Rhododendron* is accordingly more nearly completely known than the other genera. A number of subgenera are recognized.

A. The subgenus *Eurhododendron* includes all except about one hundred of the species. It is divided into three sections:

1. *Leiorhodion* Rehder. Leaves not scaly. This section includes a great many species in central Asia, and probably a clear majority of the species of the genus. It is represented in the Malay region only by a single species, *R. moulmainense*, in the western extremity of the region, the Malay Peninsula.

2. *Lepipherum* G. Don. Leaves scaly; ovary scaly; bud scales white ciliate. This is the type section; the species are distributed through Europe, Asia, and North America. There are many species in the Malay Region.

3. *Vireya*. Leaves moderately scaly; ovary not densely scaly, often pubescent; bud scales not white ciliate. This section, of which the type is *R. javanicum*, is confined to the Malay region, and includes most of the species of that region. Schlechter arranged the New Guinean species of *Rhododendron* in "sections;" most of these groups should be regarded as subsections of *Vireya*.

Recently,[45] in ignorance of Schlechter's work, I described a number of subsections of *Vireya,* of some of which the names will have to be replaced by those of Schlechter. The necessary changing of subsectional names will not be a perfectly simple matter, because some of the groups described by Schlechter are probably not represented in the Philippines, while others appear not to be natural, including species of *Lepipherum* as well as of *Vireya.*

B. The subgenus *Anthodendron* (commonly called *Azalea*) includes nearly one hundred species of eastern Asia and of North America. It is represented in the Malay region only in the northernmost extension of that region, in northern Luzon, and only by a single species, *R. subsessile.*

There are several other subgenera, each of only a few species, and not represented in the Malay region.

Xolisma Rafinesque in Am. Month. Mag. 4 (1819) 193. This genus, long neglected, was restored by Britton as a segregate from *Andromeda* or *Pieris,* from which it is distinguished by thickened capsule-sutures, by lack of appendages on the anthers, and in many species by the presence of appendages at the summits of the filaments. Rehder[46] has made the combination *Xolisma ovalifolia* (Wallich), for a species which, with many varieties, extends from the Himalayas to Japan and Formosa, and enters the westernmost extension of the Malay region in the Malay Peninsula. The species had previously been included in *Andromeda, Lyonia,* and *Pieris,* most persistently in the last. Rehder makes it the type of a section *Pieridopsis.*

Gaultheria [Kalm] Linn., Sp. Pl. (1753) 395, and *Diplycosia* Blume Bijdr. (1826) 857, are fully discussed in connection with their Philippine representatives.

Pernettyopsis King and Gamble in Journ. As. Soc. Beng. 74:2 (1905) 79. Three species confined to the Malay Peninsula.

Disiphon Schlechter in Engler's Bot. Jahrb. 55 (1918) 166. A single species in northeastern New Guinea, an epiphyte at moderate elevations, known by a single collection. Lacking fruit, Schlechter could not assign it with confidence to any tribe or subfamily. The leaves are large, lance-acuminate; the flowers, few in lax racemes, have barrel-shaped corollas about 15 mm long.

[45] Philip. Journ. Sci. 40 (1929) 133–179.

[46] Journ. Arn. Arb. 5 (1924) 52.

Iaera may be compared with *Costera* J. J. Smith in Ic. Bogor. 4 (1910) t. 324, with a single species, *C. ovalifolia*, on the islands Karimata and Madjang, west of Borneo, where it seems to have been collected only by Teysmann. Mention of *Iaera* and *Costera* involves a discussion of the classification of the subfamily Vaccinioideæ. Bentham and Hooker established two tribes, Vaccinieæ (they wrote *Euvaccinieæ*), chiefly in the northern hemisphere, with comparatively small flowers, the filaments separate and fairly long as compared with the anthers; and Thibaudieæ, chiefly in South America, with large flowers, the filaments usually shorter than the anthers, contiguous or connate. Drude maintained the same tribes; he omitted mention of flower size in the descriptions, but added another distinction, that in Vaccinieæ "Frkn. vom Blütenstiel scharf abgesetzt und oft abgegliedert," while in Thibaudieæ, "Kelch am Frkn. herablaufend und im Blütenstiel übergehend (selten abgegliedert)." Now in *Iaera* and *Costera* the flowers are minute, and the filaments are as distinct as in any species of *Vaccinium;* on the other hand, these alone among the known Vaccinioideæ of the Malay region have no articulation between the pedicel and the ovary. They are excluded by the accepted definition of either tribe, and may safely be recognized as genera, while their relationships remain in doubt. The distinctive characters of *Costera* (the separate petals and five stamens) probably mark a less primitive genus than *Iaera,* although the latter occurs farther from the continent of Asia.

Vaccinium Linn., Sp. Pl. (1753) 349. I have already [47] discussed this genus, to which many species of the Malay region have been assigned, in connection with the Philippine species, but cannot refrain from further comment. The present situation is much as in 1852, when the elder Hooker remarked:[48]

> While the recent labours of Dr. Wight on the Vacciniaceous plants of India have induced him to refer all known to him (including the genera *Agapetes, Ceratostemma,* and *Thibaudia* of Authors) to the true *Vaccinium,* Dr. Klotzsch's investigations of the *entire* family have led him to the opinion that the genera require to be multiplied, so that we find in the "Linnaea", vol. xxiv. (for 1851), no less than fourteen new genera added, and the previously existing ones thus increased to twenty-eight!

In the course of their attempt to get rid of such situations, the authors of the Genera *Plantarum* recognized the following as Vacciniaceous genera occurring in the East Indies: *Vac-*

[47] Philip. Journ. Sci. 42 (1930) 537–607.
[48] Bot. Mag. t. 4688.

cinium (subgenus *Epigynium*), *Agapetes, Pentapterygium, Rigiolepis,* and the new *Corallobotrys.* Drude, in the Natürlichen Pflanzenfamilien, made only a single insignificant change in the list. This treatment scarcely represents a real understanding of the group. The difficulties in the way of attaining such understanding become more evident from time to time, as species peculiar in one way or another are discovered. No well considered arrangement is here offered, but only the following list of groups currently included in *Vaccinium,* for each of which there are to be discovered distinctive characters (or the lack of them), definite lists of species, and relationships:

1. *Epigynium* proper; plants of the mainland of Asia, with serrate leaves, including *V. serratum, V. leschenaultii. V. neilgherrense,* and *V. donianum. Vaccinium malaccense* probably does not belong with these.

2. *Vaccinium dunalianum,* and a number of related species with entire leaves, such as *V. petelotii,*[49] *V. poilanei,* and others recently described by M. Dop. These also are confined to the continent of Asia.

3. *Nesococcus,* proposed by myself, to include most of the species of the Malay region, excepting New Guinea: ovary ten-celled, with many seeds in one column in each cell; flowers usually in racemes. This group includes most of the *species non satis notae* assigned to *Epigynium* in the original description of that group, as a genus, by Klotzsch.

4. *Galeopetalum* J. J. Smith,[50] with a single species, *V. dialypetalum,* from Java. This appears to differ from *Nesococcus* only in having separate petals, which is probably a derived character.

5. *Vaccinium uniflorum* J. J. Smith and *V. monanthum* Ridley are known each by a single collection from Borneo; they are characterized by minute solitary flowers.

6. *Rigiolepis* (Hooker f.). This group, described as having only ten seeds in the fruit, is represented in Java and Borneo. It has now been treated as a separate genus, and now reduced

[49] *Vaccinium petelotii* Merrill in Univ. Calif. Publ. Bot. 13 (1926) 138 is represented by *Petelot 1772* and *3.115,* collected at Chapa in Indo-China. In view of the existence of this name, I propose *Vaccinium dopii* nom. nov. (*V. petelotii* Dop in Fl. Gen. Indo-Chine 3:6 (1930) 703) for a different species collected by the same explorer at the same locality. Merrill's species appears to be different from all the new species described by Dop.

[50] Ic. Bogor. 4 (1912) 101.

to *Vaccinium;* it has most recently been restored by Ridley [51], who remarks that "By some curious error Merrill has reduced *Rigiolepis borneensis* [the type] to *Vaccinium acuminatissimum,* Miq., with which it has nothing in common. W. W. Smith described it as *Vaccinium borneense,* without recognizing it as the original *Rigiolepis borneensis."* It should be noticed that it was not Merrill but Boerlage [52] who reduced *Rigiolepis borneensis,* with an extensive discussion including the statement that "de afbeelding toch in HOOKER'S Icones t. 1160 bewijst dat *R. Borneensis Hook. f.* een vorm is van *V. acuminatissimum Miq.* en zelfs identik met MIQUEL'S *forma Borneensis* dezer soort. De eierstok is daar evenals bij andere *Vaccinium*-soorten door valsche tusschenschotten 10-hokkig en elk hokje bevat 1–2 of meer eitjes. Ook *V. leptanthum Miq.* moet als een vorm dezer soort beschouwd worden." We have here the statement that *Vaccinium acuminatissimum* (significantly included by Blume in *Gaylussaccia*) has a spuriously ten-celled ovary with *one, two, or more* ovules in each cavity; that *V. leptanthum* shows the same character; and that *Rigiolepis borneensis* is *Vaccinium acuminatissimum* forma *borneense* Miq. All this is not inconsistent with the possibility that *Rigiolepis* should be restored as a genus and *R. borneensis* as a species: but at least, neither the genus nor the species is far removed from others.

7. *Oarianthe* Schlechter; a group of small-leaved species with solitary flowers and five-celled ovaries, numerous in New Guinea. The assignment to this group of *V. microphyllum* Miq., of the Moluccas, Celebes, and the Philippines, is tentative.

8. *Neojunghuhnia* (Koorders), numerous in New Guinea, with racemose flowers and five-celled ovaries. The Bornean *V. cordifolium* Stapf is tentatively assigned to this group. Koorders recognized the presence of *Vaccinium* in New Guinea, but was confused by an immature specimen, on the basis of which he described *Neojunghuhnia* [53] as a remarkable new genus. His error was corrected by J. J. Smith,[54] but Koorders' name remains as the oldest for the group.

9. *Macropelma* Klotzsch. Type, *V. cereum.* The Polynesian group, of which thirteen species have been described; some of which, however, are very doubtful. The flowers are axillary on

[51] Kew Bull. (1922) 106–108.
[52] Handl. Fl. Nederl. Ind. 2 (1891) 263.
[53] Nova Guinea 8 (1909) 183.
[54] Meded. Rijks Herb. Leiden 25 (1915) 13.

rather long pedicels. Skottsberg[55] discusses the systematic position of this group; he suggests, not very confidently, a connection with the boreal section *Myrtillus,* the type section of the genus. The possibility that *Macropelma* is closest to *Neojunghuhnia* or *Oariantha* should be investigated.

Probably most or all of these groups will eventually be removed from *Vaccinium,* with the establishment of several genera.

Agapetes G. Don, Gen. Syst. 3 (1834) 862. I have quoted above, at second hand, Wight's opinion on the status of this genus. The group is so close to the representatives of *Vaccinium* in the same region, that one can hardly accept the action of Bentham and Hooker, and of Drude, in referring it to the Thibaudieæ. The type is *A. setigera;* this and several of the other species have notably large flowers, and notably short, laterally contiguous stamens. These probably constitute a tenable genus. Only four species enter the Malay region, in its western extremity, the Malay Peninsula; these have flowers no larger than many species of *Vaccinium.* Ridley distinguishes them from the *Vaccinia* of the Malay Peninsula by the shape of the corolla, a character whose value in distinguishing genera is questionable.

Paphia Seeman in Journ. Bot. 2 (1864) 77. Type, *P. vitiensis,* of Fiji. This genus was reduced to *Agapetes* by Bentham and Hooker, and was restored by Drude. Schlechter added four species; he described two from northeastern New Guinea, and transferred *Vaccinium helenae* F. v. M., of British New Guinea, and *Agapetes meiniana* F. v. M., of Queensland. If the genus is tenable, *A. queenslandica* Domin should probably be transferred to it. I am not aware of any characters separating *Paphia* from *Agapetes,* but the geographic gap between New Guinea and India leads me to expect that differences will be detected.

Pentapterygium Klotzsch in Linnæa 24 (1851) 47. Type, *P. serpens.* A small group, in eastern Asia; very close to *Agapetes,* but definitely distinguishable by the winged calyx.

Dimorphanthera F. v. M. in Wing's Southern Science Record n. s. 2 (1886). Type, *D. moorhousiana.* This fairly large genus, mostly New Guinean, is closely related to the three preceding, but is very definitely distinguishable by the dimorphous anthers from which the name is taken. I discuss the group more fully in connection with the Philippine species.

Wittsteinia F. v. M. in Frag. Phyt. Austr. 2 (1861) 136. The single species, from Victoria, has very much the aspect of the

[55] Bishop Mus. Bull. 43 (1927) 87.

Vaccinia of section *Macropelma;* but the anthers are not of the type characteristic of the family.

The numbers of species known in the various genera just discussed are shown in Table 1.

TABLE 1.—*Distribution of species in the various genera of Ericaceæ.*

Genus.	Malay Peninsula.	Sumatra.	Java.	Borneo.			Philippine Islands.	Celebes.
				Dutch.	Sarawak.	British North.		
Rhododendron	19	9	9	7	19	14	21	5
Xolisma	1							
Gaultheria	3	4	3			1	3	1
Diplycosia	6	3	3	1	5	14	8	2
Pernettyopsis	3							
Disiphon								
Iaera							3	
Costera				1				
Vaccinium	17	16	13	6	12	9	29	7
Agapetes	4							
Paphia								
Pentapterygium	1							
Dimorphanthera							2	
Wittsteinia								
Total	54	32	28	15	36	38	66	15

Genus.	Moluccas etc.	New Guinea.			Australia.	Pacific Islands.	Total.	
		Dutch.	British.	Northeast.			Malay Region.	World.
Rhododendron		58	14	29	1		181	850
Xolisma							1	31
Gaultheria		5	1		1		15	130
Diplycosia	[a] 2	4		4			41	41
Pernettyopsis							3	3
Disiphon				1			1	1
Iaera							3	3
Costera							1	1
Vaccinium	[b] 3	48	6	17		[d] 10	166	370
Agapetes							4	48
Paphia			1	2	2	1	6	6
Pentapterygium							1	7
Dimorphanthera	[c] 1	17	3	10			32	32
Wittsteinia					1		1	1
Total	6	132	25	63	5	11	455	1,524

[a] One in Amboyna, one in Lombok.

[b] Two in Tidor and Ternate; one in Timor.

[c] One in Amboyna.

[d] Six in Hawaii, fide Skottsberg in Bishop Mus. Bull. 43 (1927) 65–87; one in Tahiti and the Marquesas, two in Samoa, and one in the New Hebrides.

EXCLUDED GENERA

Catanthera F. v. M. in Journ. Bot. 24 (1886) 289. A single species, *C. lysipetala,* was described to include *Forbes 419* and *451,* from British New Guinea. This name, long an ornament to lists of *genera incertæ sedis,* was shown by Schlechter [56] to belong to some Melastomaceous plant.

Mischopleura Wernham in Hooker's Ic. Pl. (1916) t. 3059. Two species, based on plants collected by the Wollaston Expedition to Dutch New Guinea, were described. On studying the generic description, I could scarcely believe that these plants belong to Ericaceæ. *Mischopleura* appears to differ from *Hibbertia* only in having one style instead of two or more, and may confidently be assigned to the Dilleniaceæ.

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Work toward the taxonomic revision of the Philippine Ericaceæ which I here conclude was undertaken in 1927, at the University of California; at the suggestion, and under the guidance, of Dr. E. D. Merrill. For the purpose of this work, Doctor Merrill secured loans of the material of Philippine and Malayan Ericaceæ in the herbarium of the Bureau of Science at Manila, and in the United States National Herbarium. I must acknowledge a very great obligation to the authorities in charge of these respective herbaria. I have also had access to the herbarium of the University of California, and to the Dudley Herbarium of Stanford University.

When Doctor Merrill was called to the directorship of the New York Botanic Garden in January, 1930, Dr. L. R. Abrams of Stanford University undertook the supervision of the remainder of my work. Among those who have steadily helped me in every way possible, I must mention, with Doctor Merrill and Doctor Abrams, my father, Dr. E. B. Copeland. It is my earnest hope that my work may be found worthy of the standing, as botanists and as teachers, of these gentlemen.

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ILLUSTRATIONS

PLATE 1

FIG. 1. *Gaultheria leucocarpa, Palmer and Bryant 1117,* stamen, × 20.
2. *Gaultheria cumingiana, Clemens 16392,* stamen, × 20.
3. *Gaultheria psilocarpa,* type, stamen, × 20.

FIGS. 4 and 5. *Gaultheria benguetensis,* type, stamens, × 20.

FIG. 6. *Diplycosia loheri,* cotype, foliage and flowers, natural size.
7. *Diplycosia loheri,* type, stamen, × 10.

PLATE 2

FIG. 1. *Diplycosia trinervia, Elmer 13800,* stamens, × 10.
2. *Diplycosia trinervia, Elmer 13800* foliage and flowers, natural size.
3. *Diplycosia luzonica, For. Bur. 30072 Sulit,* flower, × 5.
4. *Diplycosia luzonica, For. Bur. 30072 Sulit,* flower in longitudinal section, × 5.
5. *Diplycosia luzonica, For. Bur. 7892 Curran and Merritt,* immature fruit, × 5.
6. *Diplycosia luzonica, Clemens 17822,* seeds, × 20.

PLATE 3

FIG. 1. *Diplycosia luzonica, For. Bur. 30072 Sulit,* stamen and anther, × 10.
2. *Diplycosia luzonica, Merrill 5670,* stamen, × 10.
3. *Diplycosia luzonica, For. Bur. 4779 Mearns and Hutchinson,* stamen, × 10.
4. *Diplycosia luzonica, Bur. Sci. 38540 Ramos and Edaño,* stamen, × 10.
5. *Diplycosia luzonica, Quisumbing, 1306,* foliage and flowers, natural size.

PLATE 4

FIG. 1. *Diplycosia luzonica, Merrill 5670,* foliage, natural size.
2. *Diplycosia apoensis,* type, foliage, natural size.

PLATE 5

FIG. 1. *Diplycosia calelanensis, Bur. Sci. 31784 Santos,* foliage, natural size.
2. *Diplycosia opaca,* type, foliage, natural size.
3. *Diplycosia sp., Elmer 11676,* stamen and anther, × 10.

PLATE 6

FIG. 1. *Iaera lanaensis, Clemens s. n.,* fruit, × 5.
2. *Iaera lanaensis, Elmer 10103,* stamen, × 20.
3. *Iaera lanaensis, Bur. Sci. 35683 Martelino and Edaño,* stamen, × 20.

FIG. 4. *Iaera lanaensis, Elmer 10103,* foliage and fruit, natural size.
5. *Iaera lanaensis,* type, seed, × 20.
6. *Iaera lanaensis, Bur. Sci. 35683 Martelino and Edaño,* flower, × 5.
7. *Iaera lucida,* type, stamen, × 20.
8. *Iaera lucida,* type fruit, × 5.
9. *Iaera lucida,* cotype, foliage and buds, natural size.

PLATE 7

FIG. 1. *Iaera loheri, Loher 13248,* leaf, × 2½.
2. *Iaera loheri, Loher 13248,* fruit, × 5.
3. *Iaera loheri, Loher 13248* foliage and fruit, natural size.
4. *Iaera loheri, Loher 13248,* flower-bud, × 10.
5. *Iaera loheri, Loher 13248,* stamens, × 20.
6. *Dimorphanthera apoana, Whitford 1497,* flower, × 5.
7. *Dimorphanthera apoana, Whitford 1497,* ovary in cross section, diagrammatic, × 20.

PLATE 8

FIG. 1. *Dimorphanthera apoana,* type, minor stamen, × 10.
2. *Dimorphanthera apoana,* type, major stamen, × 10.
3. *Dimorphanthera apoana, Whitford 1497,* three stamens, ×10.
4. *Dimorphanthera apoana, Williams 2550,* foliage and fruit, natural size.

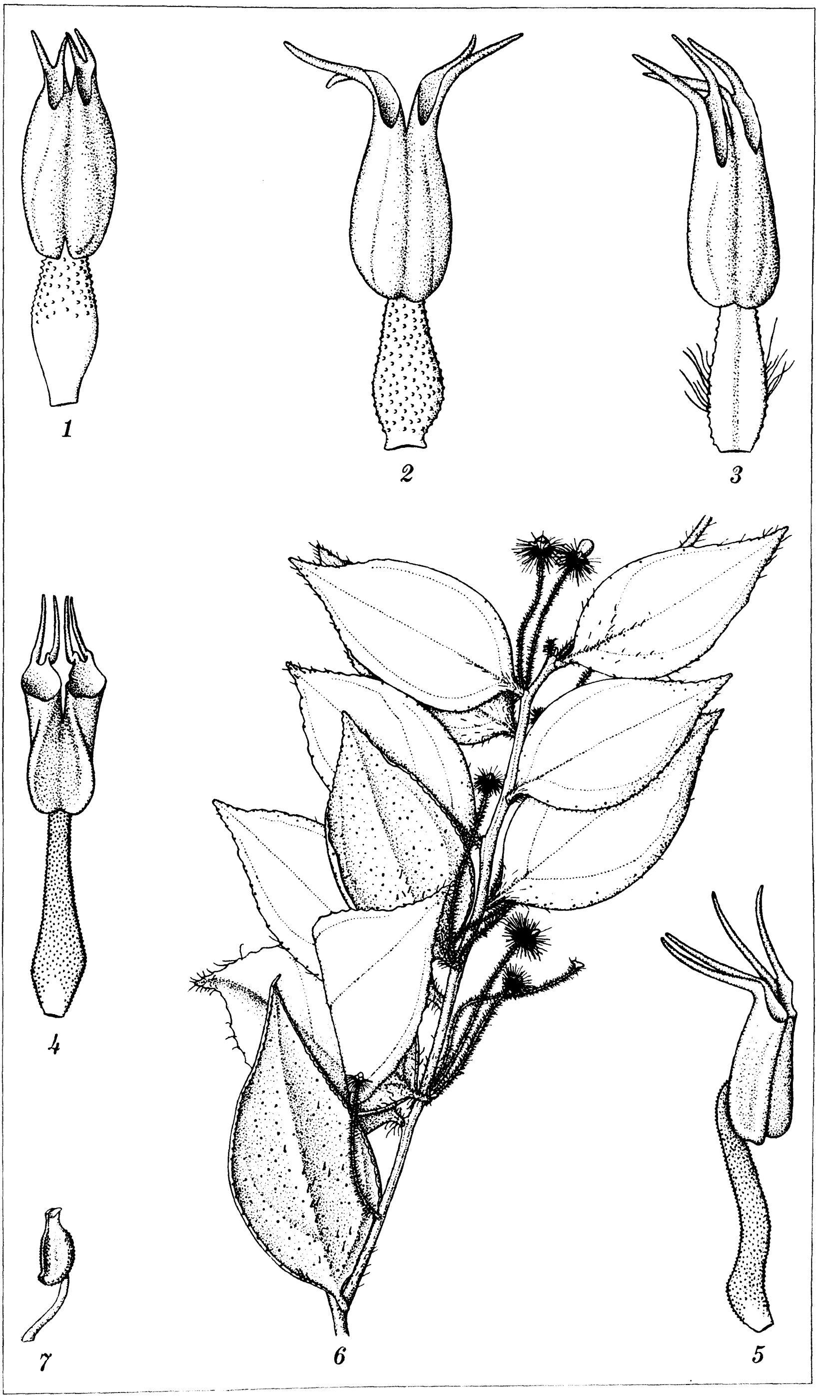
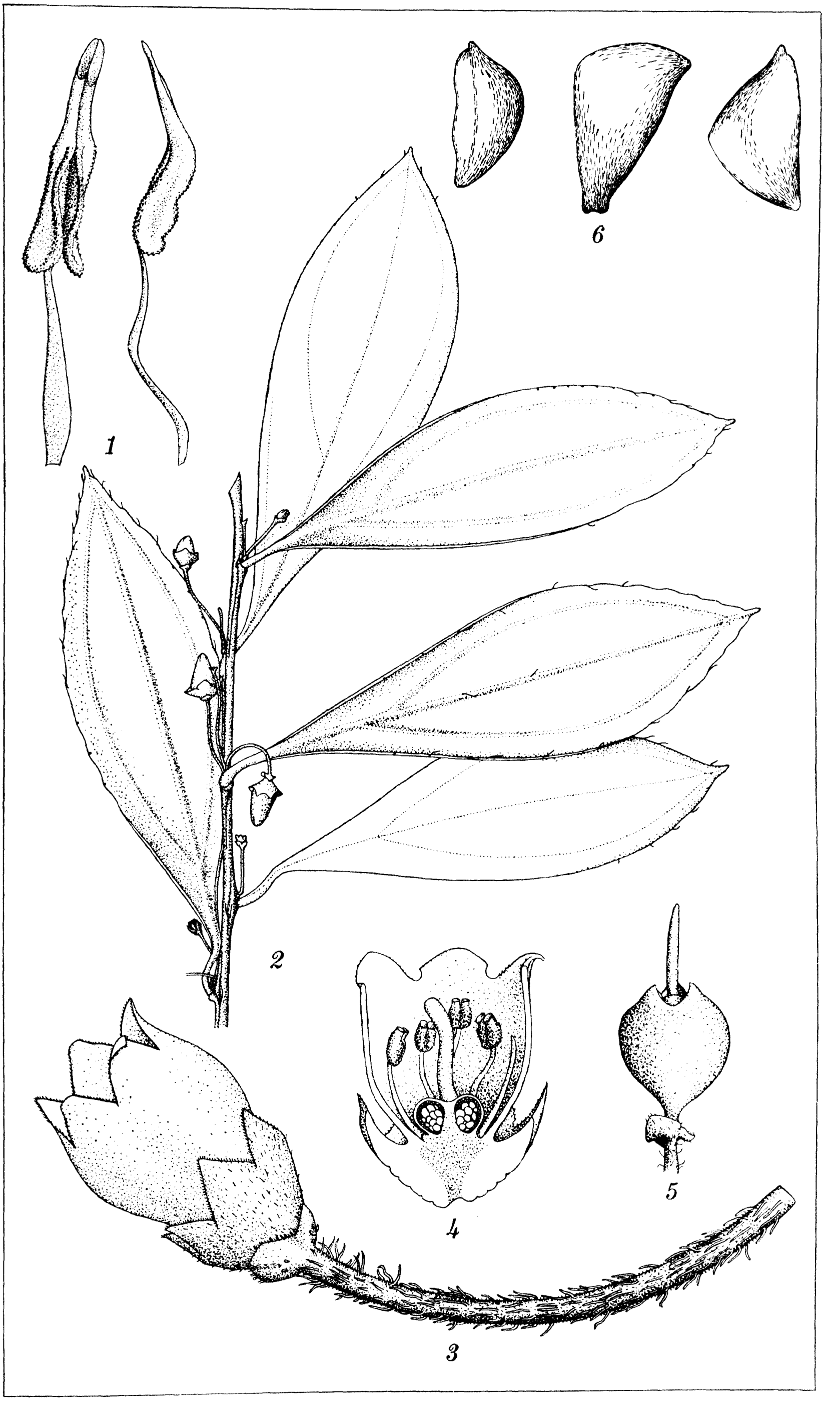


PLATE 1.



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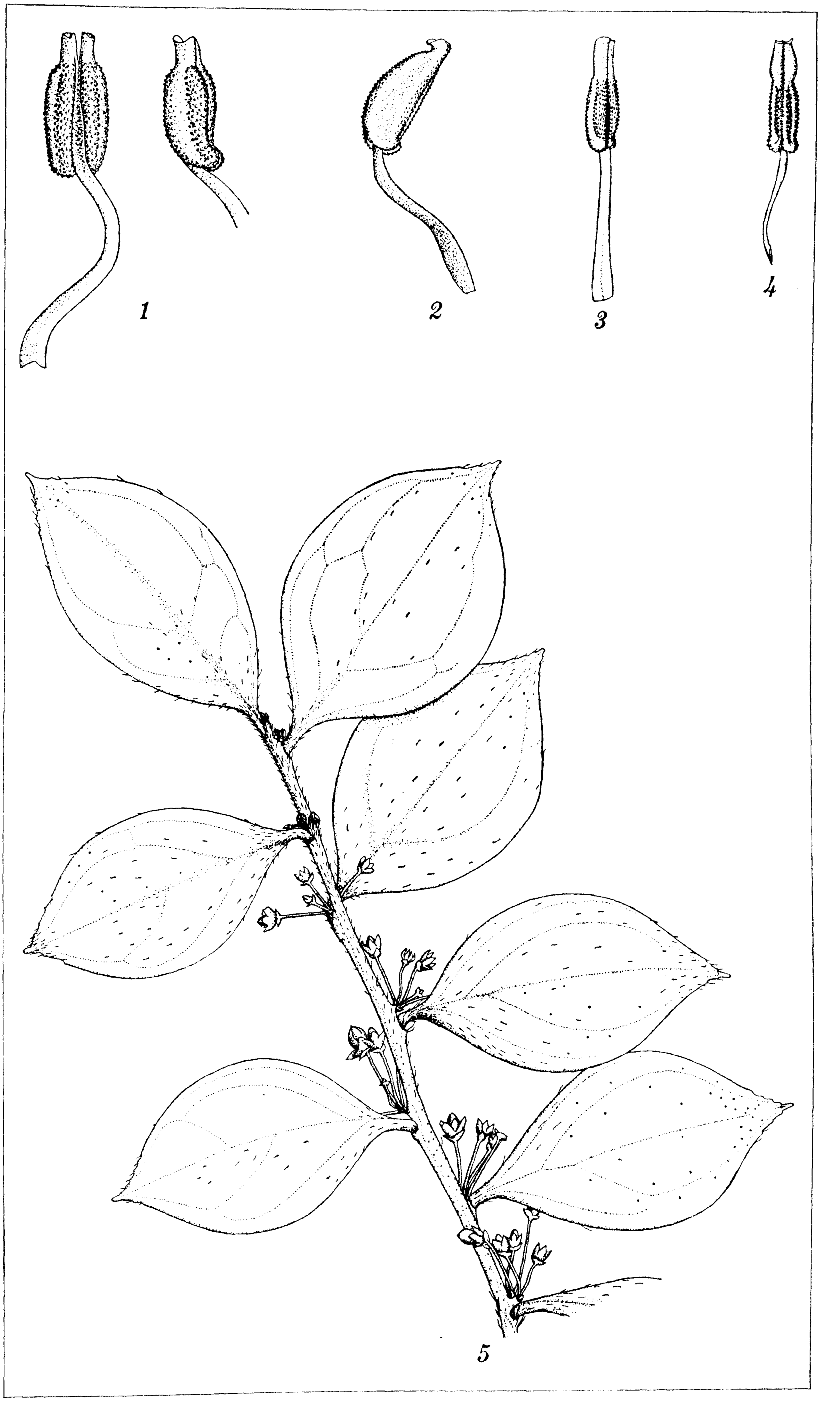

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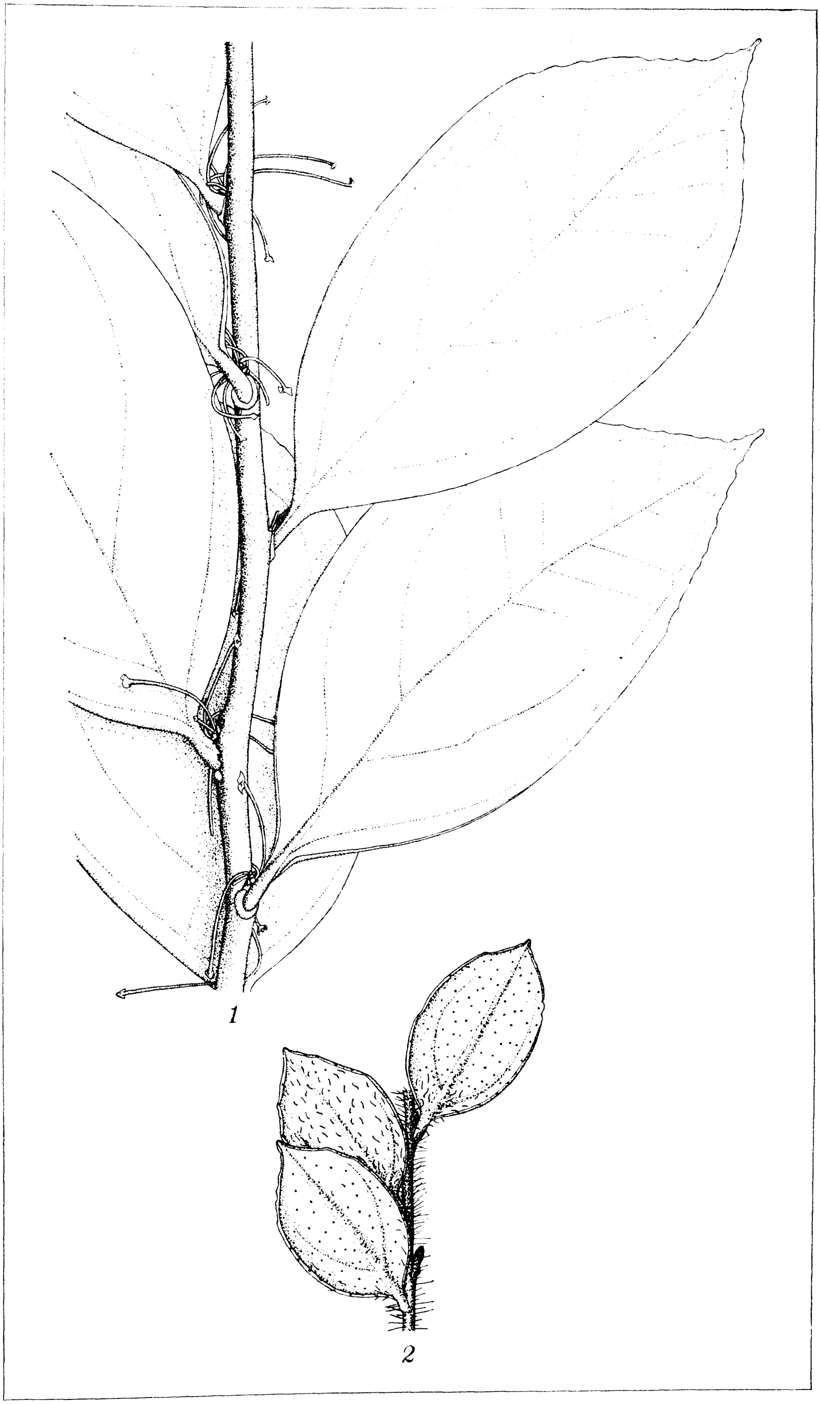

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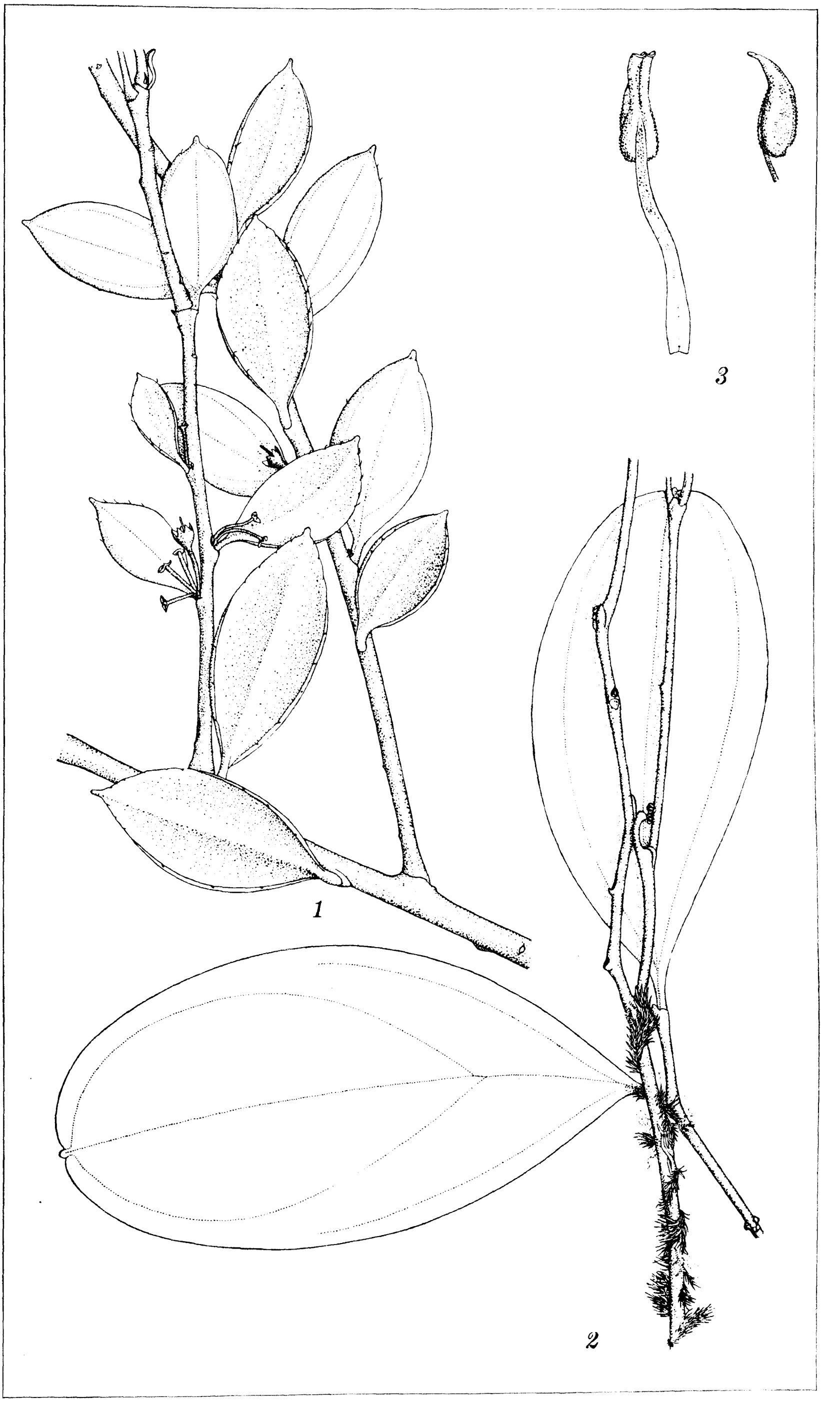

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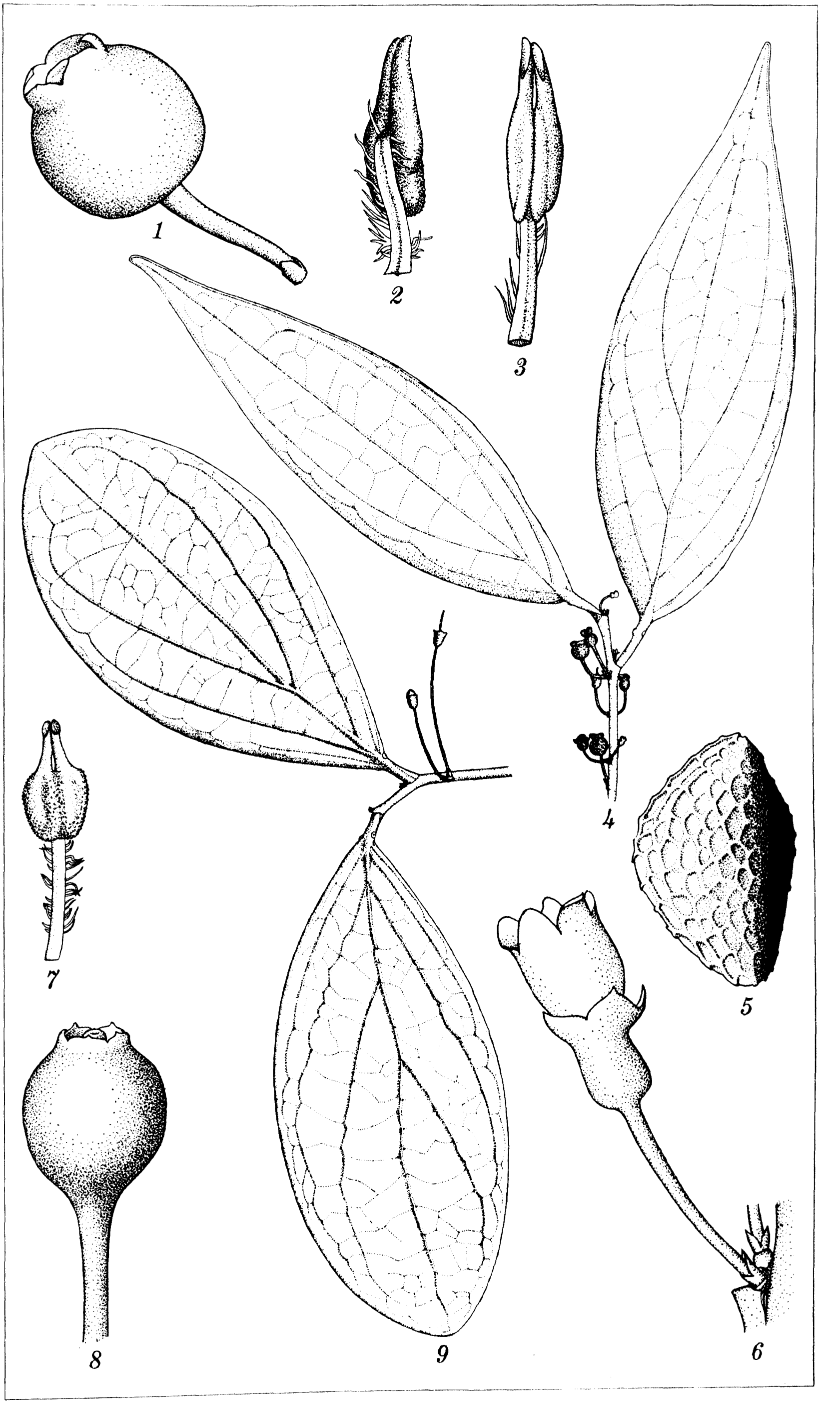


PLATE 6.

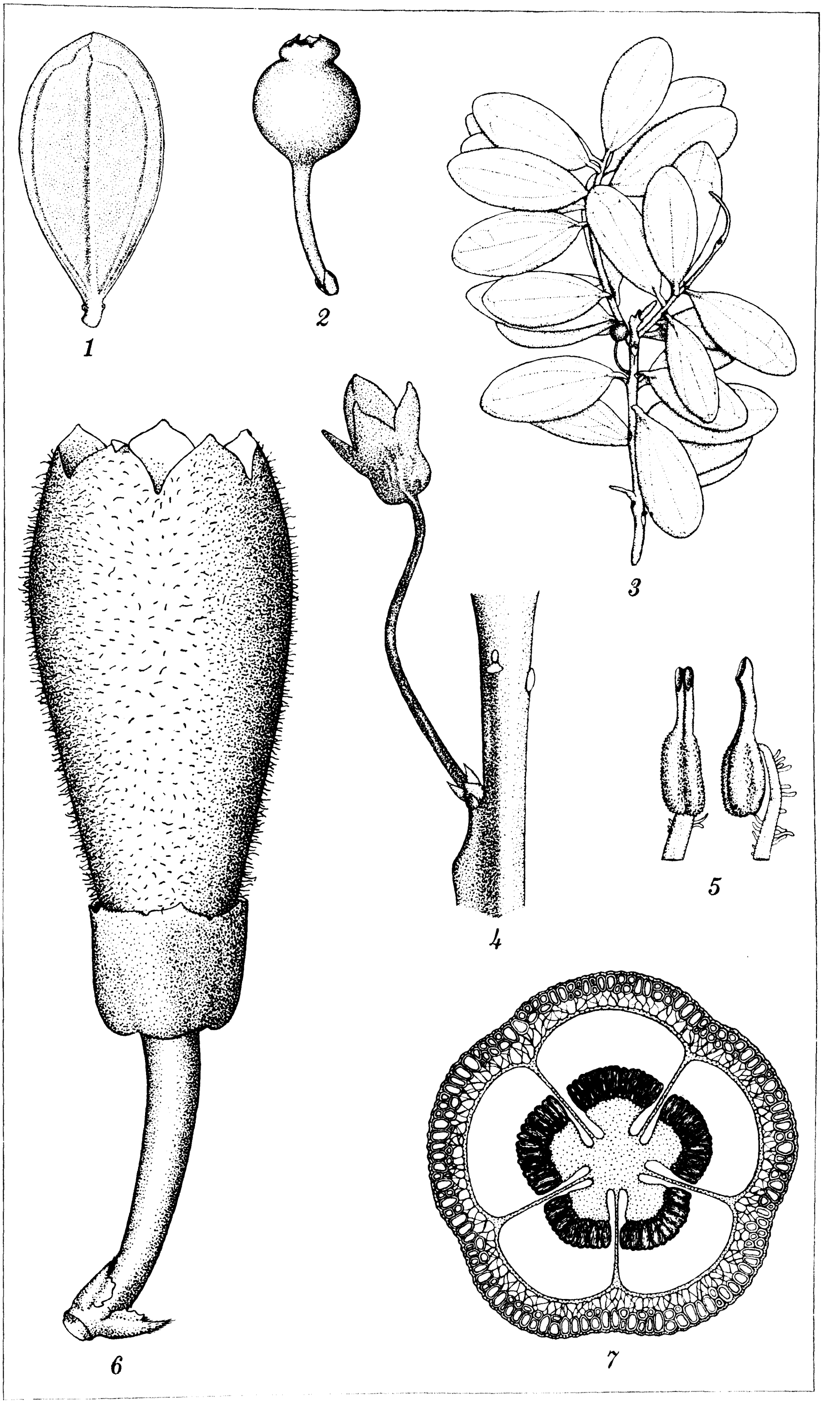


PLATE 7.

PLATE 8.

MARINE DIATOMS FROM THE KANAZAWA OYSTER EXPERIMENTAL STATION OF JAPAN

By B. W. SKVORTZOW
Of Harbin, China

TWO PLATES

The following notes on diatoms of the coast of Japan have resulted from the examination and study of a sample of marine diatoms received from Dr. Juzo Hori, of the Kanazawa Oyster Experimental Station at Kanazawa, Kanazawa-Ken, Japan, in December, 1927. The material was sufficiently rich in diatoms and the present paper lists forty-nine species and varieties, including some new forms not yet described.

MELOSIRA JUERGENSI Agardh.

V. HEURCK, Synopsis pl. 86, figs. 1–8.

Length, 0.02 millimeter; breadth, 0.013 to 0.015 millimeter. Geographic distribution: North and Mediterranean Seas, Pacific Ocean.

MELOSIRA SULCATA (Ehrenb.) Kützing.

A. SCHMIDT, Atlas Diatom. pl. 176, figs. 28, 32–39, 42–44, 46; pl. 178, figs. 1-5, 7-19, 22-24.

Length, 0.01 millimeter; breadth, 0.04 to 0.05 millimeter. Geographic distribution: North and Mediterranean Seas, Pacific Ocean.

CYCLOTELLA STYLORUM Brightwell. Plate 2, fig. 1.

A. SCHMIDT, Atlas Diatom. pl. 223, figs. 6–8.

Valve 0.065 to 0.075 millimeter in diameter. Geographic distribution: Pacific Ocean, North and Mediterranean Seas, Sea of Japan.

CYCLOTELLA STRIATA (Kützing) Grunow. Plate 2, fig. 3.

Valve 0.025 to 0.043 millimeter in diameter. Striæ 12 to 14 in 0.01 millimeter. Geographic distribution: North, Mediterranean, and Yellow Seas, Japan, Philippine Islands.

CYCLOTELLA STRIATA (Kützing) Grunow var. BIPUNCTATA Fricke. Plate 2, fig. 2.

A. SCHMIDT, Atlas Diatom. pl. 223, figs. 15–19.

Valve with two distinct markings. Diameter 0.012 to 0.018 millimeter. Geographic distribution: North Sea.

COSCINODISCUS EXCENTRICUS Ehrenberg.

A. SCHMIDT, Atlas Diatom. pl. 58, figs. 46–49.

Valve 0.032 millimeter in diameter. Markings 5 to 7 in 0.01 millimeter. Geographic distribution: Pacific Ocean, Japan, North and Yellow Seas, Philippine Islands.

COSCINODISCUS DECRESCENS Grunow.

A. SCHMIDT, Atlas Diatom. pl. 61, figs. 7–10.

Valve 0.034 millimeter in diameter. Markings 4 in 0.01 millimeter. Geographic distribution: Pacific Ocean; fossil in marine deposits.

COSCINODISCUS EXTRAVAGANS A. Schmidt. Plate 1, fig. 3.

A. SCHMIDT, Atlas Diatom. pl. 58, fig. 33.

Valve blue, 0.032 to 0.038 millimeter in diameter. Central space distinct, circular. Markings small, granular, about 7 to 8 in 0.01 millimeter. Rows radial. Apiculi large, conical, interfasciculate, inserted at inner edge of marginal zone. Border hyaline. Geographic distribution: Japan.

COSCINODISCUS CONCINNUS W. Smith.

A. SCHMIDT, Atlas Diatom. pl. 114, figs. 8, 9.

Diameter of valves 0.046 to 0.056 millimeter. Geographic distribution: Pacific and Atlantic Oceans, Sea of Japan.

COSCINODISCUS OCULUS IRIDIS Ehrenberg. Plate 1, fig. 2.

A. SCHMIDT, Atlas Diatom. pl. 63, figs. 6, 7, 9; pl. 113, figs. 1, 3, 5, 20.

Diameter of valve 0.18 to 0.195 millimeter. Markings in the middle 4, at the border 3 in 0.01 millimeter. Geographic distribution: Pacific and Atlantic Oceans, Japan, China, Philippine Islands.

COSCINODISCUS DENARIUS A. Schmidt.

A. SCHMIDT, Atlas Diatom. pl. 5, figs. 19–21.

Diameter of valve 0.054 to 0.065 millimeter. Markings 7 to 8 in 0.01 millimeter. Geographic distribution: Atlantic Ocean, Sea of Japan.

COSCINODISCUS GIGAS Ehrenberg. Plate 1, fig. 5.

A. SCHMIDT, Atlas Diatom. pl. 64, fig. 1.

Valve 0.1 to 0.12 millimeter in diameter with 5 to 6 markings in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans, Mediterranean Sea, Japan.

COSCINODISCUS ASTEROMPHALUS Ehrenberg. Plate 1, figs. 1, 4, 7.

A. SCHMIDT, Atlas Diatom. pl. 63, fig. 5.

Diameter of valve 0.23 to 0.37 millimeter; markings 3 to 3.5 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans, North Sea, Sea of Japan.

ASTEROMPHALUS FLABELLATUS Brébisson. Plate 2, fig. 14.

A. SCHMIDT, Atlas Diatom. pl. 38, figs. 10–12.

Diameter of valves 0.035 to 0.038 millimeter. Geographic distribution: Pacific Ocean, Japan, Hongkong, Indian Ocean.

ACTINOCYCLUS EHRENBERGI Ralfs. Plate 1, fig. 6.

V. HEURCK, Synopsis pl. 123, fig. 7.

Diameter of valve 0.97 millimeter. Geographic distribution: Atlantic and Pacific Oceans, Japan, China, Philippine Islands.

ACTINOPTYCHUS UNDULATUS (Bailey) Ralfs. Plate 2, fig. 4.

V. HEURCK, Synopsis pl. 122, figs. 1–3.

Diameter of valves 0.03 to 0.05 millimeter. Geographic distribution: Atlantic and Pacific Oceans, Japan and Yellow Seas.

LICMOPHORA FLABELLATA Agardh.

V. HEURCK, Synopsis pl. 46, fig. 2.

Valves 0.139 to 0.154 millimeter in length. Geographic distribution: North and Mediterranean Seas.

SYNEDRA AFFINIS Kütz. var. PARVA Grunow.

V. HEURCK, Synopsis pl. 41, fig. 22.

Length, 0.032 to 0.04 millimeter; breadth, 0.0034 to 0.0042 millimeter. Striæ 18 in 0.01 millimeter. Geographic distribution: North and Mediterranean Seas, Japan, Ceylon.

EUCAMPIA ZODIACUS Ehrenberg.

V. HEURCK, Synopsis pl. 95, figs. 17–18.

Cell elliptical with oval foramina. Geographic distribution: Atlantic and Pacific Oceans, Malay Archipelago, Sea of Japan.

GRAMMATOPHORA ARCTICA Cleve.

V. HEURCK, Synopsis pl. 53, fig. 3.

Valve minute, rectangular. Length and breadth, 0.013 millimeter. Geographic distribution: North Sea, Spitzbergen, Sea of Japan.

GRAMMATOPHORA OCEANICA Ehrenberg var. ADRIATICA Grunow.

V. HEURCK, Synopsis pl. 53, fig. 9.

Length, 0.018 to 0.034 millimeter; width, 0.004 to 0.01 millimeter. Geographic distribution: Adriatic Sea and Pacific Ocean.

GRAMMATOPHORA OCEANICA Ehrenberg var. NODULOSA Grunow.

PERAGALLO, Diatom. Mar. France. pl. 87, fig. 21.

Length, 0.025 millimeter; breadth, 0.012 millimeter. Geographic distribution: Atlantic Ocean, Mediterranean Sea.

ACHNANTHES BREVIPES Agardh var. TYPICA Cleve.

V. HEURCK, Synopsis pl. 26, figs. 10 to 12.

Valve constricted in the middle. Length, 0.076 millimeter; breadth, 0.022 millimeter. Striæ 5 in 0.01 millimeter. Geographic distribution: Brackish waters. Arctic America, Greenland, Spitzbergen, Finmark, North, Baltic, and Caspian Seas, Japan.

ACHNANTHES BREVIPES Agardh var JAPONICA var. nov. Plate 2, figs. 12–13.

Valve linear-elliptical with rounded ends. Length, 0.127 to 0.136 millimeter; breadth, 0.017 to 0.019 millimeter. Striæ 7 to 10 in 0.01 millimeter. This new variety resembles a large form of var. *intermedia* Kützing and *A. greenlandica* Cleve.

ACHNANTHES BREVIPES Agardh var. INTERMEDIA Kütz.

Valve linear-elliptical. Length, 0.049 millimeter; breadth, 0.008 millimeter. Geographic distribution: Brackish water and marine. Finmark, coasts of Britain, North, Baltic, Caspian, and Mediterranean Seas, Sea of Japan.

ACHNANTHES LONGIPES Agardh. Plate 2, figs. 10, 11.

V. HEURCK, Synopsis pl. 26, figs. 13 to 16.

Valve linear-elliptical, constricted in the middle, and with cuneate ends. Length, 0.081 to 0.119 millimeter; breadth, 0.025 to 0.029 millimeter. Geographic distribution: Brackish water and marine. Coasts of Britain, Baltic, North, Adriatic, and Mediterranean Seas, Belgium, Saint Paul Island.

ACHNANTHES LONGIPES Agardh forma LATA Peragallo. Plate 2, figs. 7–9.

PERAGALLO, Diatom. Mar. France pl. 1, figs. 10, 11.

Valve broad-elliptic with cuneate ends. Length, 0.054 millimeter; breadth, 0.024 millimeter. Striæ 5 in 0.01 millimeter.

COCCONEIS SCUTELLUM Ehrenberg var. BALDJIKIANA Grunow. Plate 2, fig. 5.

A. SCHMIDT, Atlas Diatom. pl. 190, figs. 7 to 10.

Valve elliptical. Length, 0.032 to 0.046 millimeter; breadth, 0.018 to 0.022 millimeter. Geographic distribution: North, Mediterranean, and Baltic Seas, Baldjik (fossil).

COCCONEIS SCUTELLUM Ehrenberg var. ELONGATA var. nov.

Valve elliptical elongate. Upper valve with puncta arranged in transverse rows. Lower valve delicate with a marginal rim or line. Median lines straight. Central nodules rounded. Length, 0.034 millimeter; breadth, 0.013 millimeter. Striæ 10 in 0.01 millimeter.

COCCONEIS PLACENTULA Ehrenberg.

A. SCHMIDT, Atlas Diatom. pl. 192, figs. 38 to 51.

Valve elliptic. Length, 0.047 millimeter; breadth, 0.037 millimeter. Striæ 22 in 0.01 millimeter. Geographic distribution: Fresh or brackish waters. Europe, Baltic and Caspian Seas, Tasmania, New Zealand, Illinois, California, Siberia.

NAVICULA CLAVATA Gregory var. CARIBOENA A. Schmidt forma MINOR Cleve.

A. SCHMIDT, Atlas Diatom. pl. 2, fig. 17; pl. 70, fig. 48.

Valve elliptical with rostrate ends. Lateral areas constricted in the middle. Length, 0.037 millimeter; breadth, 0.023 millimeter. Striæ 10 to 12 in 0.01 millimeter. Geographic distribution: Jamaica, North and Mediterranean Seas, Colon.

NAVICULA SCOPULORUM Brébisson.

V. HEURCK, Synopsis 99, Suppl. B, fig. 28.

Valve linear, slightly gibbous in the middle. Ends broad, rounded. Length, 0.21 to 0.023 millimeter; breadth, 0.016 to 0.018 millimeter. Striæ distinctly punctate, 20 in 0.01 millimeter. Geographic distribution: England, Mediterranean and Adriatic Seas, Sumatra, Labuan, Japan, East Cape, North Siberia, Brazil.

NAVICULA GRANULATA Bailey.

A. SCHMIDT, Atlas Diatom. pl. 6, figs. 26, 27.

Valve elliptic-lanceolate. Length, 0.085 millimeter; breadth, 0.037 millimeter. Striæ 9 in 0.01 millimeter. Geographic distribution: North and Mediterranean Seas, Ceylon, Japan, Sydney, California guano.

NAVICULA VIRIDULA Kützing var. **ROSTELLATA** Kützing.

V. HEURCK, Synopsis pl. 7, fig. 23.

Valve lanceolate with attenuated ends. Length, 0.044 millimeter; breadth, 0.008 millimeter. Striæ 8 to 9 in 0.01 millimeter. Geographic distribution: Brackish waters. England, Belgium, East Cape, Japan.

NAVICULA (SCHIZONEMA) MOLLIS W. Smith.

Valve lanceolate, obtuse. Length, 0.034 millimeter; breadth, 0.007 millimeter. Striæ 13 to 15 in 0.01 millimeter. Geographic distribution: Adriatic and North Seas.

NAVICULA (SCHIZONEMA) GREVILLEI Agardh.

Valve lanceolate with rounded ends. Length, 0.047 millimeter; breadth, 0.015 millimeter. Striæ 15 in 0.01 millimeter. Geographic distribution: Spitzbergen, Finmark, North Sea, coasts of England, Arctic America, Greenland, Cape Deschneff, West Indies, Kerguelen Land, California.

CALONEIS LIBER W. Smith var. **LINEARIS** Grunow.

Valve linear with parallel margins and rounded ends. Length, 0.045 millimeter; breadth, 0.01 millimeter. Striæ 21 in 0.01 millimeter. Geographic distribution: Atlantic coasts of Europe, Africa and America, Japan Sea, Vladivostok, Ceylon, Singapore, Galapagos Islands, Peru, Honduras, Gulf of Mexico.

PLEUROSIGMA STUXBERGII Cleve and Grunow var. **LATUISCULA** Peragallo.

PERAGALLO, Monogr. Pleurosigma 15, pl. 6, fig. 12.

Valve lanceolate, slightly sigmoid. Ends obtuse. Length, 0.115 millimeter; breadth, 0.022 millimeter. Transverse and oblique striæ 23/20 in 0.01 millimeter. Geographic distribution: North and Mediterranean Seas.

PLEUROSIGMA ELONGATUM W. Smith.

PERAGALLO, Monogr. Pleurosigma pl. 3, figs. 5 to 8.

Valve elongate, slightly sigmoid, attenuate to the acute ends. Length, 0.23 millimeter; breadth, 0.02 millimeter. Geographic

distribution: Spitzbergen, Atlantic coast of North America, North, Mediterranean, Adriatic, Baltic, and Caspian Seas, Java, Sumatra, China, Tahiti, Medoc.

PLEUROSIGMA ANGULATUM Quekett.

PERAGALLO, Monogr. Pleurosigma pl. 5, fig. 3.

Valve rhomboidal-lanceolate, slightly angular in the middle. Length, 0.102 millimeter; breadth, 0.02 millimeter. Geographic distribution: North Sea, Barbados deposits.

PLEUROSIGMA NUBICULA W. Smith var. **INTERMEDIA** W. Smith.

PERAGALLO, Monogr. Pleurosigma pl. 5, figs. 27, 28.

Valve narrow-lanceolate not sigmoid, with long ends. Length, 0.18 millimeter; breadth, 0.0136 millimeter. Striæ 25/25 in 0.01 millimeter. Geographic distribution: North Sea, Port Jackson, Sea of Japan.

PLEUROSIGMA ACUMINATUM Kützing var. **GALLICA** Grunow.

Valve sigmoid, lanceolate with attenuate ends. Length, 0.127 millimeter; breadth, 0.025 millimeter. Striæ 25 in 0.01 millimeter. Geographic distribution: Fresh and brackish waters. Sweden, France, Argentina.

AMPHORA ANGUSTA (Greg.) Cleve var. **VENTRICOSA** Gregory forma **JAPONICA** forma nov.

Valve narrow, semilanceolate, acute. Length, 0.068 millimeter; breadth, 0.008 millimeter. Striæ 15 in 0.01 millimeter.

GOMPHONEMA KAMTSCHATICUM Grunow var. **JAPONICA** Skvortzow.

Marine Diatom. Siber. Shore 17, fig. 17.

Length, 0.02 millimeter; breadth, 0.003 millimeter. Striæ 15 in 0.01 millimeter. Geographic distribution: Sea of Japan.

NITSCHIA VIVAX Smith var. **JAPONICA** var. nov.

Valve lanceolate with subrostrate ends. Length, 0.093 to 0.0068 millimeter. Coarse border lines 7 in 0.01 millimeter. Fine lines 25 to 30 in 0.01 millimeter.

NITSCHIA LORENZIANA Grunow var. **DENSESTRIATA** Peragallo.

A. SCHMIDT, Atlas Diatom. pl. 335, figs. 9–11.

Length, 0.136 millimeter; breadth, 0.007 millimeter. Fine striæ 25 in 0.01 millimeter. Coarse margin lines 6 in 0.01 millimeter. Geographic distribution: North and Mediterranean Seas, Borneo, Ceylon.

NITZSCHIA LONGISSIMA Brébisson.

PERAGALLO, Diatom. Mar. France pl. 74, fig. 20.

Length, 0.51 to 0.65 millimeter; breadth, 0.01 millimeter. Geographic distribution: Adriatic, North, and Mediterranean Seas, Atlantic Ocean, Japan.

NITSCHIA SOCIALIS Gregory var. **BALTICA** Grunow.

Length, 0.081 millimeter; breadth, 0.005 millimeter. Coarse dorsal lines 6 in 0.01 millimeter. Fine lines 20 in 0.01 millimeter. Geographic distribution: North Sea.

SURIRELLA FASTUOSA Ehrenberg. Plate 2, fig. 6.

A. SCHMIDT, Atlas Diatom. pl. 5, figs. 7, 8, 11.

Length, 0.034 to 0.064 millimeter; breadth, 0.025 to 0.047 millimeter. Geographic distribution: A cosmopolitan marine diatom.

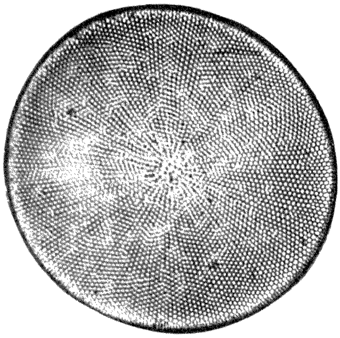
ILLUSTRATIONS

PLATE 1

FIG. 1. *Coscinodiscus asteromphalus* Ehrenberg.
2. *Coscinodiscus oculus iridis* Ehrenberg.
3. *Coscinodiscus extravagans* Schmidt.
4. *Coscinodiscus asteromphalus* Ehrenberg.
5. *Coscinodiscus gigas* Ehrenberg.
6. *Actinocyclus ehrenbergi* Ralfs.
7. *Coscinodiscus asteromphalus* Ehrenberg.

PLATE 2

FIG. 1. *Cyclotella stylorum* Brightwell.
2. *Cyclotella striata* (Kützing) Grunow var. *bipunctata* Fricke.
3. *Cyclotella striata* (Kützing) Grunow.
4. *Actinoptychus undulatus* (Bail.) Ralfs.
5. *Cocconeis scutellum* Ehrenberg var. *baldjikiana* Grunow.
6. *Surirella fastuosa* Ehrenberg.
FIGS. 7 to 9. *Achnanthes longipes* Agardh forma *lata* Peragallo.
FIGS. 10, 11. *Achnanthes longipes* Agardh.
FIGS. 12, 13. *Achnanthes brevipes* Agardh var. *japonica* var. nov.
FIG. 14. *Asteromphalus flabellatus* Brébisson.



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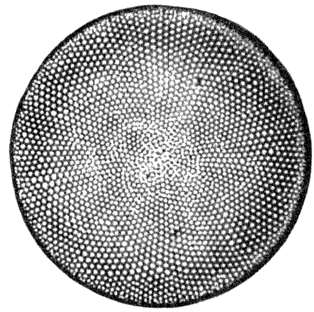

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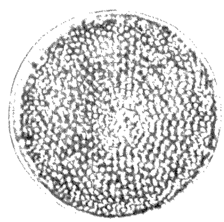

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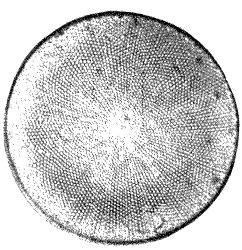

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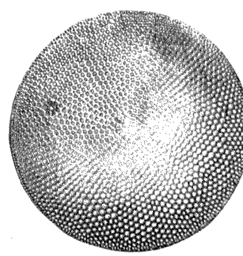

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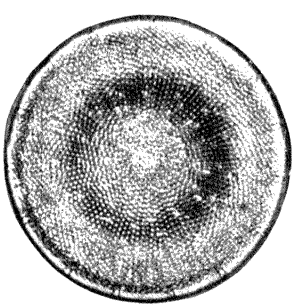

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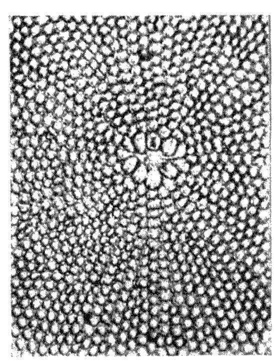


7

PLATE 1.

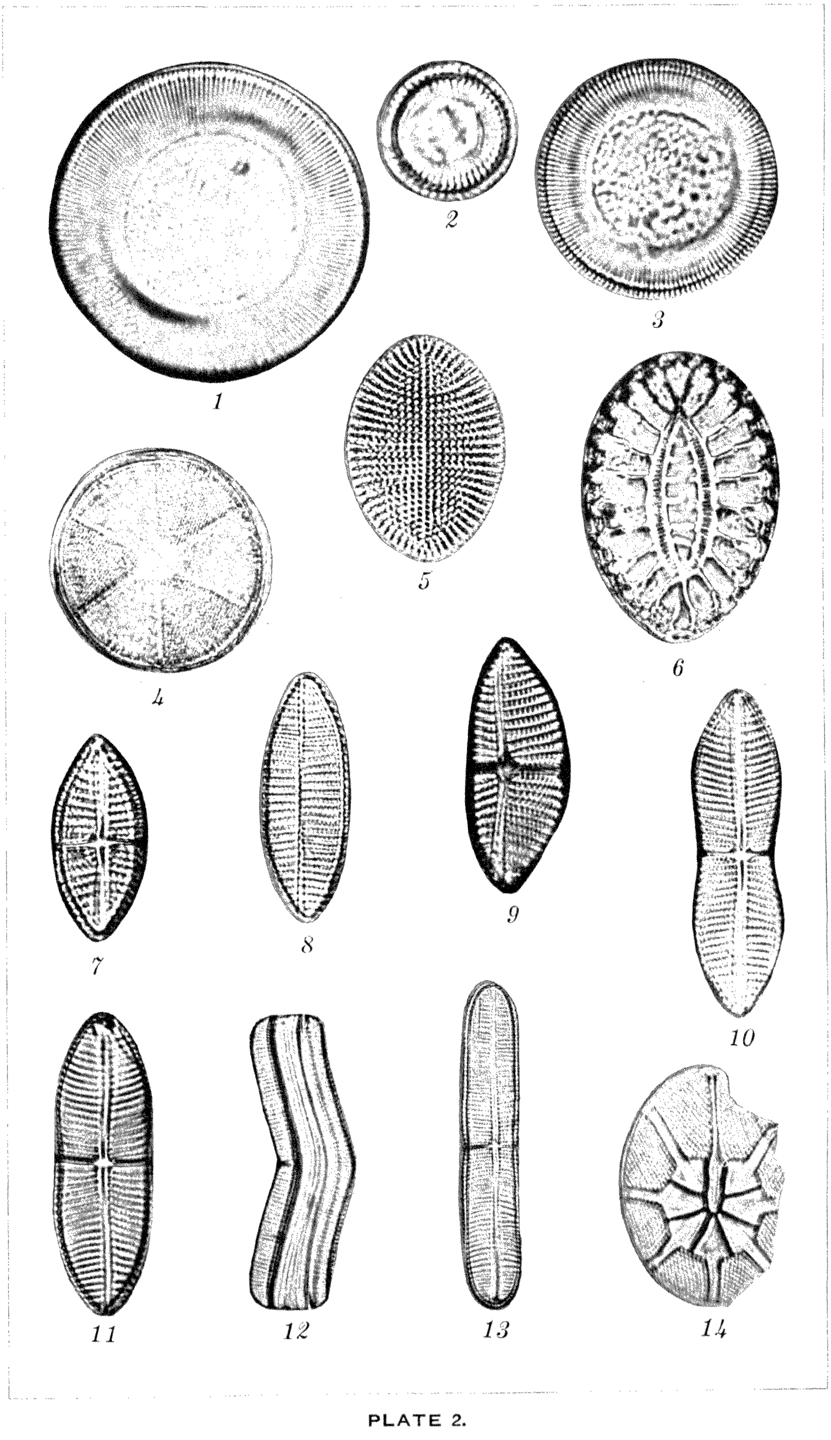


PLATE 2.

MARINE LITTORAL DIATOMS FROM ENVIRONS OF VLADIVOSTOK

By B. W. SKVORTZOW

Of Harbin, China

SIX PLATES

The diatoms of the northern part of the Sea of Japan are relatively very little known. Only two enumerations of forms observed in samples from Vladivostok have been published by me; one in the Botanical Magazine in Tokyo in 1929, the other in the Philippine Journal of Science in 1931. Scarcely more than forty-two marine species are enumerated in the papers quoted above. Since that time I have examined some new diatom material collected by me during my visit to Vladivostok in the summer of 1928. These new samples were taken from Golden Horn Bay and from Cape Basargino near the Pacific Fishery Research Station. Altogether six samples have been examined:

1. Basargino, near the seashore, from the twigs of *Sargassum* sp.
2. Basargino, near the seashore, from *Laminaria japonica*.
3. Basargino from oyster mud dredged by the Fishery Station.
4. Vladivostok, from the piles near the seashore.
5. Okeanskaya station from *Zostera* sp.
6. Okeanskaya station from *Sargassum* sp.

All mentioned samples, except sample 3, contained a large number of diatoms, typical of the littoral association with an epiphytic nature. Sample 3 was rich in different *Coscinodiscus*, *Cyclotella*, *Navicula*, and *Amphora*. Samples 5 and 6 from the seashore of Okeanskaya station had a number of diatoms known in brackish waters, as *Hyalodiscus*, *Licmophora*, *Synedra*, *Cocconeis*, *Nitschia*, and *Surirella*.

All the samples yielded one hundred thirty-two forms of these algæ, a list of which is given below. This note is illustrated with diagrams by the author and the number after each species corresponds to the locality from which it was obtained.

PODOSIRA MONTAGNEI Kützing.

V. HEURCK, Synopsis pl. 84, figs. 9, 10.

Length, 0.088 to 0.009 millimeter; breadth, 0.03 to 0.06 millimeter. Geographic distribution: North, Mediterranean, and Caspian Seas, Ceylon. Samples 1, 5, and 6.

HYALODISCUS SCOTICUS (Kützing) Grunow.

PERAGALLO, Diatom. Mar. France 443, pl. 119, fig. 8.

Diameter of the valves 0.013 to 0.027 millimeter. Geographic distribution: Spitzbergen, Finmark, North and Black Seas. Samples 1, 3, and 5.

HYALODISCUS AMBIGUUS Grunow. Plate 1, fig. 1.

PERAGALLO, Diatom. Mar. France. pl. 19, fig. 19.

Diameter of the valves 0.127 to 0.13 millimeter. Diameter of umbilicus 0.01 millimeter. Striæ 18 in 0.01 millimeter. Geographic distribution: Atlantic Ocean, Mediterranean Sea. Samples 1 and 5.

STEPHANOPYXIS TURRIS (Grev. and Arn.) Ralfs var. INTERMEDIA Grunow. Plate 1, figs. 2, 3.

GRUNOW, Genkschr. Akad. Wissen. (1884) 35–37, figs. 15, 16.

Valves 0.017 to 0.02 millimeter thick. Geographic distribution: Atlantic and Pacific Oceans, known from the Sea of Japan. Sample 3.

CYCLOTELLA STRIATA (Kützing) Grunow. Plate 1, figs. 6–9.

Diameter of the valve 0.042 to 0.049 millimeter. Striæ 12 in 0.01 millimeter. Geographic distribution: North, Japan, and Yellow Seas, Philippine Islands. Sample 3.

CYCLOTELLA STRIATA (Kützing) Grunow var. AMBIGUA Grunow. Plate 1, figs. 4, 5.

V. HEURCK, Synopsis pl. 92, fig. 12.

Diameter of the valve 0.027 millimeter. Striæ 15 in 0.01 millimeter. Geographic distribution: Brackish waters. Sample 3.

COSCINODISCUS OCULUS IRIDIS Ehrenberg.

A. SCHMIDT, Atlas Diatom. pl. 63, figs. 6, 7, 9.

Diameter of the valve 0.161 to 0.25 millimeter. Markings 2 to 3 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans, Japan, China, Hongkong, Philippine Islands. Sample 3.

COSCINODISCUS LINEATUS Ehrenberg. Plate 2, fig. 8.

A. SCHMIDT, Atlas Diatom. pl. 59, figs. 31, 32.

Diameter of the valves 0.06 to 0.8 millimeter. Geographic distribution: Atlantic and Pacific Oceans, Kamchatka, Sea of Japan, China and Yellow Seas. Samples 3 and 4.

COSCINODISCUS EXCENTRICUS Ehrenberg. Plate 3, fig. 2.

A. SCHMIDT, Atlas Diatom. pl. 58, figs. 46–49.

Diameter of the valves 0.047 to 0.062 millimeter. Markings 5 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans, Japan, Philippine Islands. Samples 3 and 4.

COSCINODISCUS RADIATUS Ehrenberg. Plate 2, figs. 2, 3, 4.

A. SCHMIDT, Atlas Diatom. pl. 60, figs. 1–6, 9, 10; pl. 61, fig. 13.

Diameter of the valves 0.119 to 0.135 millimeter. Markings 3 to 4 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans, Sea of Japan, China and Yellow Seas, Hongkong. Sample 3.

COSCINODISCUS DENARIUS A. Schmidt. Plate 2, figs. 5, 6.

A. SCHMIDT, Atlas Diatom. pl. 57, figs. 19–21.

Diameter of the valves 0.052 to 0.073 millimeter. Markings 4 to 6 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans. Sample 3.

COSCINODISCUS CURVATULUS Grunow.

A. SCHMIDT, Atlas Diatom. pl. 57, fig. 33.

Diameter of the valves 0.054 to 0.7 millimeter. Markings 6 to 7 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans, Sea of Japan. Samples 1 and 3.

COSCINODISCUS CURVATULUS Grunow var. MINOR (Ehrenberg) Grunow. Plate 2, fig. 9.

GRUNOW, Diatom. Franz Josef Land 33, pl. D, figs. 8, 10.

Diameter of the valves 0.027 to 0.035 millimeter. Markings 7 in 0.01 millimeter. Geographical distribution: North Sea. Sample 3.

COSCINODISCUS CURVATULUS Grunow var. JAPONICA var. nov. Plate 2, fig. 7.

Diameter of the valves 0.032 to 0.05 millimeter. Central space small granular or absent. Markings in fasciculate rows. Border distinct, nonapiculate. Sample 3.

COSCINODISCUS MARGINATUS Ehrenberg. Plate 2, fig. 1.

A. SCHMIDT, Atlas Diatom. pl. 62, figs. 1–5, 7, 11, 12.

Diameter of the valves 0.047 to 0.078 millimeter. Markings 3 to 4 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans, Kamchatka, Sea of Japan, China and Yellow Seas. Samples 1 and 3.

ACTINOPTYCHUS UNDULATUS (Bailey) Ralfs. Plate 3, fig. 1.

V. HEURCK, Synopsis pl. 122, figs. 1, 3.

Diameter of the valves 0.035 to 0.038 millimeter. Geographic distribution: Atlantic and Pacific Oceans, Sea of Japan, Yellow and North Seas. Sample 3.

ASTEROMPHALUS HEPTACTIS (Brébisson) Ralfs. Plate 3, fig. 4.

A. SCHMIDT, Atlas Diatom. pl. 38, figs. 5–8.

Diameter of the valves 0.042 to 0.05 millimeter. Geographic distribution: Atlantic Ocean, California, Peru, Sea of Japan. Sample 3.

AULACODISCUS AMOENUS Greville. Plate 3, fig. 5.

A. SCHMIDT, Atlas Diatom. pl. 34, fig. 6; pl. 134, fig. 7.

Diameter of the valves 0.076 to 0.095 millimeter. Geographic distribution: Pacific Ocean, Sea of Japan. Samples 1 and 3.

AULISCUS COELATUS Bailey var. **STRIGILLATA** A. Schmidt. Plate 3, fig. 6.

A. SCHMIDT, Atlas Diatom. pl. 32, figs. 24–26.

Diameter of the valves 0.036 to 0.053 millimeter. Geographic distribution: Atlantic and Pacific Oceans, Sea of Japan, Philippines. Sample 1.

RHIZOSOLENIA SETIGERA Brightwell.

PERAGALLO, Rhizosolenia pl. 4, figs. 12–16.

Valve 0.011 millimeter in breadth. Geographic distribution: Atlantic and Pacific Oceans, Sea of Japan, Philippines. Sample 3.

CHAETOCEROS COMPRESSUM Lauder.

A. SCHMIDT, Atlas Diatom. pl. 323, figs. 3–5; pl. 341, figs. 1, 9.

Valves 0.02 millimeter broad. Geographic distribution: Atlantic and Pacific Oceans, Sea of Japan. Sample 1.

BIDDULPHIA OBTUSA Grunow. Plate 6, fig. 10.

V. HEURCK, Synopsis pl. 100, figs. 11–14.

Length, 0.051 to 0.063 millimeter; breadth, 0.02 to 0.025 millimeter. Geographic distribution: New York, North and China Seas, Vladivostok, Philippines. Sample 5.

BIDDULPHIA AURITA Brébisson. Plate 3, fig. 9; Plate 6, fig. 3.

A. SCHMIDT, Atlas Diatom. pl. 122, figs. 1–8.

Length, 0.042 to 0.62 millimeter; breadth, 0.023 to 0.028 millimeter. Marginal spines distinct. Geographic distribution: At-

lantic and Pacific Oceans, Japan, Vladivostok, Yellow Sea, Philippines. Sample 1.

BIDDULPHIA AURITA Brébisson var. **ORIENTALIS** Mereschkovski. Plate 6, fig. 4.

MERESCHKOVSKY, on Polynesian Diatom. (1900–1902); A. SCHMIDT, Atlas Diatom. pl. 12, figs. 5–8.

Length, 0.056 to 0.067 millimeter. Geographic distribution: Atlantic and Pacific Oceans. Sample 1.

RHABDONEMA ARCUATUM (Lyngbye) Kützing. Plate 5, fig. 3.

A. SCHMIDT, Atlas Diatom. pl. 220, figs. 17–22.

Length, 0.076 to 0.113 millimeter; breadth, 0.018 to 0.02 millimeter. Striæ 4.5 to 6 in 0.01 millimeter. Geographic distribution: Atlantic Ocean, Mediterranean Sea, Japan, Australia, Philippines. Sample 1.

GRAMMATOPHORA ANGULOSA Ehrenberg. Plate 6, fig. 5.

PERAGALLO, Diatom. Mar. France 357, pl. 88, figs. 11–13

Length, 0.017 to 0.039 millimeter; breadth, 0.008 to 0.018 millimeter. Striæ 12 to 15 in 0.01 millimeter. Geographic distribution: North Sea, California. Sample 1.

GRAMMATOPHORA ANGULOSA Ehrenberg var. **ISLANDICA** Ehrenberg. Plate 6, fig. 11.

PERAGALLO, Diatom. Mar. France pl. 88, figs. 14–15.

Length, 0.059 millimeter; breadth, 0.022 millimeter. Striæ 12 in 0.01 millimeter. Geographic distribution: Atlantic Ocean, North and Japan Seas. Sample 1.

GRAMMATOPHORA OCEANICA Ehrenberg var. **MACILENTA** Smith.

V. HEURCK, Synopsis 164, pl. 53, fig. 16.

Length, 0.022 to 0.078 millimeter; width, 0.006 to 0.007 millimeter. Geographic distribution: Adriatic Sea, Pacific Ocean, Japan, Philippines. Samples 1, 3, 5.

GRAMMATOPHORA MARINA (Lyngbye) Kützing.

V. HEURCK, Synopsis 163, pl. 53, fig. 10.

Length, 0.042 to 0.068 millimeter; breadth, 0.012 to 0.018 millimeter. Striæ 18 to 20 in 0.01 millimeter. Geographic distribution: Mediterranean Sea, Pacific Ocean, Japan, China, Philippines. Samples 1 and 5.

LICMOPHORA LYNGBYEI Kützing var. **ELONGATA** Grunow. Plate 6, fig. 7.

PERAGALLO, Diatom. Mar. France pl. 85, fig. 8.

Length, 0.085 to 0.111 millimeter; breadth, 0.005 millimeter. Geographic distribution: North Sea. Sample 5.

LICMOPHORA JURGENSII Agardh var. **CHERSONENSIS** Grunow.

V. HEURCK, Synopsis pl. 46, fig. 9.

Length, 0.0103 millimeter; breadth, 0.005 millimeter. Striæ 15 in 0.01 millimeter. Geographic distribution: North and Mediterranean Seas. Samples 1 and 5.

LICMOPHORA JURGENSII Agardh var. **CAPENSIS** Grunow.

V. HEURCK, Synopsis pl. 46, fig. 8.

Length, 0.042 millimeter; breadth, 0.0076 to 0.0085 millimeter. Striæ 14 to 15 in 0.01 millimeter. Geographic distribution: Mediterranean and North Seas. Sample 4.

LICMOPHORA GRACILIS (Kützing) Ehrenberg. Plate 6, fig. 1.

V. HEURCK, Synopsis pl. 46, fig. 13.

Length, 0.034 millimeter; breadth, 0.007 millimeter. Geographic distribution: North and Mediterranean Seas. Sample 4.

LICMOPHORA COMMUNIS (Heib.) Grunow. Plate 6, fig. 2.

V. HEURCK, Synopsis pl. 48, figs. 8, 9.

Length, 0.013 to 0.054 millimeter; breadth, 0.015 millimeter. Geographic distribution: North and Mediterranean Seas. Samples 4 and 5.

SYNEDRA PULCHELLA Kützing.

A. SCHMIDT, Atlas Diatom. pl. 300, figs. 19–35.

Length, 0.074 to 0.046 millimeter; breadth, 0.0045 millimeter. Striæ 15 to 18 in 0.01 millimeter. Geographic distribution: Fresh and brackish waters. Sample 5.

SYNEDRA AFFINIS Kützing var. **TABULATA** Grunow. Plate 6, fig. 15.

V. HEURCK, Synopsis pl. 41, fig. 9A.

Valve 0.079 to 0.085 millimeter in length; 0.004 to 0.006 millimeter in breadth. Striæ 9 to 11 in 0.01 millimeter. Geographic distribution: Marine and brackish waters. A cosmopolitan diatom. Samples 2 and 4.

SYNEDRA AFFINIS Kützing var. **HYBRIDA** Grunow. Plate 6, fig. 14.

V. HEURCK, Synopsis pl. 41, fig. 9B.

Length, 0.119 to 0.175 millimeter; breadth, 0.0034 to 0.004 millimeter. Striæ 11 to 15 in 0.01 millimeter. Geographic distribution: Marine and brackish waters. Samples 1 and 5.

FRAGILARIA OCEANICA Cleve var. **JAPONICA** var. nov. Plate 6, fig. 9.

Valve elliptical-linear, with parallel margins. Ends slightly cuneate and rounded. Length, 0.019 to 0.21 millimeter; breadth,

0.003 to 0.004 millimeter. Striæ 15 in 0.01 millimeter. Sample 3.

FRAGILARIA OCEANICA Cleve var. ACUTA var. nov. Plate 6, fig. 8.

Valve elliptic-linear with acute, subrostrate, rounded ends. Striæ marginal, about 18 to 22 in 0.01 millimeter. Length of valve, 0.025 to 0.032 millimeter; breadth, 0.004 to 0.007 millimeter. Geographic distribution: Typical *F. oceanica* Cleve, Bihang K. Sv. Vet. Akad. Handl. Bd. 1, No. 13, 22, pl. 4, fig. 25, occurs in Arctic and Kara Seas. Sample 3.

THALASSIOTHRIX NITZSCHIOIDES Grunow.

V. HEURCK, Synopsis pl. 43, figs. 7–10.

Length, 0.023 to 0.025 millimeter; breadth, 0.0025 millimeter. Striæ 15 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans, Japan, China. Samples 1 and 4.

ACHNANTHES BREVIPES Agardh var. INTERMEDIA Kützing.

V. HEURCK, Synopsis 129, pl. 26, figs. 21–24.

Valve linear-elliptical with rounded ends. Length, 0.0408 to 0.054 millimeter; breadth, 0.0085 to 0.01 millimeter. Striæ 6 to 9 in 0.01 millimeter. Geographic distribution: Brackish and marine waters. Sample 6.

COCCONEIS ARCTICA Cleve.

A. SCHMIDT, Atlas Diatom. pl. 196, fig. 10; pl. 197, figs. 5, 6.

Valve elliptical. Length, 0.037 millimeter; breadth, 0.025 millimeter. Striæ 12 in 0.01 millimeter. Geographic distribution: Arctic America, Greenland, Finmark. Samples 2 and 5.

COCCONEIS PELLUCIDA Hantzsch.

A. SCHMIDT, Atlas Diatom. pl. 194, fig. 2; pl. 195, figs. 1–8.

Valve broadly elliptical. Length, 0.025 to 0.064 millimeter; breadth, 0.02 to 0.047 millimeter. Striæ 20 in 0.01 millimeter. Geographic distribution: Nicobar Islands, Java, Sumatra, Singapore, Sandwich Islands, Bering Island, Madagascar, New Zealand, fossil in Hungary and Haiti. Samples 5 and 6.

COCCONEIS PELLUCIDA Hantzsch var. MINOR Grunow.

GRUNOW, Novara Diatom. 13, pl. 1, fig. 7.

Valve elliptical. Length, 0.015 to 0.018 millimeter; breadth, 0.0085 to 0.010 millimeter. Geographic distribution: Red Sea, Saint Paul Island, Cape of Good Hope, Nicobar Islands, New Zealand, Trinidad. Samples 5 and 6.

COCCONEIS SCUTELLUM Ehrenberg var. **STAURONEIFORMIS** W. Smith.

V. HEURCK, Synopsis pl. 29, figs. 10, 11.

Valve minute, elliptical. Length, 0.019 millimeter; breadth, 0.011 millimeter. Puncta 10 in 0.01 millimeter. Geographic distribution: Arctic America, Spitzbergen, Finmark, East Cape, North and Mediterranean Seas, New Zealand, England. Sample 1.

COCCONEIS SCUTELLUM Ehrenberg var. **PARVA** Grunow.

V. HEURCK, Synopsis pl. 29, figs. 8, 9.

Valve minute, elliptical. Length, 0.013 to 0.029 millimeter; breadth, 0.009 to 0.012 millimeter. Striæ 6.5 to 7 in 0.01 millimeter. Geographic distribution: East Cape, Baltic, Adriatic, and Yellow Seas. Sample 1.

COCCONEIS SCUTELLUM Ehrenberg var. **JAPONICA** Skvortzow. Plate 3, fig. 7; Plate 4, figs. 1 to 8.

Marine Diatom. Siber. Shore (1929) 57, figs. 2, 14; Marine Diatom. Dairen, 421, pl. 1, fig. 8.

Valve with large loculi, arranged in more or less undulating longitudinal and transverse rows. Length, 0.042 to 0.061 millimeter; breadth, 0.034 to 0.045 millimeter. Puncta 4.5 in 0.01 millimeter. Geographic distribution: Sea of Japan, Vladivostok and Dairen. Samples 1 and 6.

COCCONEIS SCUTELLUM Ehrenberg var. **ORNATA** Grunow. Plate 3, fig. 11.

V. HEURCK, Synopsis pl. 29, figs. 6, 7.

Valve broadly elliptical. Length, 0.035 millimeter; breadth, 0.025 millimeter. Geographic distribution: Pacific Ocean, Kamchatka and Yellow Seas. Sample 1.

COCCONEIS COSTATA Gregory var. **TYPICA** Cleve.

V. HEURCK, Synopsis pl. 30, figs. 11, 12.

Valve elliptic with strong transverse costæ. Length, 0.017 millimeter; breadth, 0.085 millimeter. Geographic distribution: Arctic America, Greenland, Davis Strait, Canada, Spitzbergen, Finmark, Bering Island, North Mediterranean and Adriatic Seas. Samples 2 and 6.

COCCONEIS DIRUPTA Gregory var. **ANTARCTICA** Grunow. Plate 3, fig. 10.

V. HEURCK, Synopsis pl. 29, figs. 18, 19.

Valve broad elliptical. Length, 0.044 millimeter; breadth, 0.032 millimeter. Striæ about 12 in 0.01 millimeter. Geographic distribution: New Zealand, China. Sample 1.

COCCONEIS DIRUPTA Gregory var. SIGMA Pantocsek. Plate 5, fig. 1.

Fossil Baccil. Ungarns pl. 8, fig. 68.

Valve broad elliptical or orbicular. Upper valve with a rhomboidal or orbicular central area. Length, 0.054 millimeter; breadth, 0.014 millimeter. Geographic distribution: Ceylon, California, Japan (fossil). Sample 3.

COCCONEIS HETEROIDEA Hantsch. Plate 5, fig. 2; Plate 6, fig. 29.

A. SCHMIDT, Atlas Diatom. pl. 196, figs. 2, 33–37, 40, 41.

Valve broadly elliptical. Length, 0.027 to 0.085 millimeter; breadth, 0.018 to 0.069 millimeter. Geographic distribution: Seychelles, Madagascar, Mauritius, Nicobar Islands, Singapore, Japan, China, Sandwich Islands, Samoa, West Indies, Colon. Sample 1.

PINNULARIA QUADRATAREA A. Schmidt var. UNDULATA var. nov. Plate 5, fig. 5.

Valve linear, with subcuneate ends. The middle part of the valve slightly undulate. Length, 0.06 millimeter; breadth. 0.0085 millimeter. Striæ 10 in 0.01 millimeter. Sample 3.

PINNULARIA CLAVICULUS Gregory var. JAPONICA var. nov. Plate 6, fig. 13.

Valve linear, slightly constricted, dividing the valve into three segments. The constriction in the middle part small. Length, 0.062 millimeter; breadth, 0.011 millimeter. Striæ 8 in 0.01 millimeter. Geographic distribution: Typical *P. claviculus* is found in North Sea, Sweden, Balearic Islands, Java, and fossil in Hungary. Sample 3.

NAVICULA LYRA Ehrenberg var. SUBELLIPTICA Cleve forma. Plate 6, fig. 12.

Valve elliptical, not rostrate. Length, 0.035 to 0.04 millimeter; breadth, 0.022 millimeter. Striæ 10 to 12 in 0.01 millimeter. Geographic distribution: Spitzbergen, Finmark, North Sea, Japan, Philippines, fossil in Hungary and California. Sample 1.

NAVICULA LYRA Ehrenberg var. ELLIPTICA A. Schmidt.

Valve elliptical with subrostrate ends. Length, 0.059 to 0.06 millimeter; breadth, 0.023 to 0.025 millimeter. Striæ 10 in 0.01 millimeter. Geographic distribution: North, Mediterranean, and Red Seas, Ceylon, Madagascar, Sumatra, Philippines. Sample 1.

NAVICULA LYRA Ehrenberg var. SUBTYPICA A. Schmidt.

A. SCHMIDT, Atlas Diatom. pl. 2, fig. 24.

Valve elliptical, with parallel margins. Length, 0.072 millimeter; breadth, 0.034 millimeter. Striæ 12 in 0.01 millimeter.

Geographic distribution: North and Mediterranean Seas. Sample 1.

NAVICULA LYRA Ehrenberg var. INTERMEDIA Peragallo. Plate 5, fig. 9.

PERAGALLO, Diatom Mar. France pl. 23, figs. 6, 7.

Length, 0.076 to 0.085 millimeter; breadth, 0.037 to 0.04 millimeter. Striæ 12 in 0.01 millimeter. Geographic distribution: North and Mediterranean Seas. Sample 3.

NAVICULA FORCIPATA Greville var. DENSESTRIATA A. Schmidt. Plate 5, fig. 6.

A. SCHMIDT, Atlas Diatom. pl. 70, figs. 12–16; Nord Sea Diatom. pl. 1, fig. 44.

Valve elliptical, elongate. Length, 0.051 millimeter; breadth, 0.015 millimeter. Striæ 12 in 0.01 millimeter. Geographic distribution: North Sea, Corsica, Cape of Good Hope, Java, Japan, Campeche Bank. Samples 2 and 7.

NAVICULA DIRECTA W. Smith var. GENUINA Cleve.

A. SCHMIDT, Atlas Diatom. pl. 46, figs. 4, 5.

Valve linear-lanceolate, gradually tapering from the middle to the acute ends. Length, 0.068 to 0.105 millimeter; breadth, 0.0068 to 0.01 millimeter. Striæ 7 to 10 in 0.01 millimeter. Geographic distribution: Arctic and North Seas. Samples 1 and 3.

NAVICULA VIRIDULA Kützing var. ROSTELLATA Kützing.

V. HEURCK, Synopsis 84, pl. 7, fig. 24.

Valve lanceolate. Length, 0.03 millimeter; breadth, 0.005 millimeter. Striæ 12 in 0.01 millimeter. Geographic distribution: England, Belgium, Japan. Sample 5.

NAVICULA VIRIDULA Kützing var. JAPONICA var. nov. Plate 6, fig. 16.

Valve lanceolate, gradually tapering from the middle to the obtuse ends. Length, 0.03 millimeter; breadth, 0.0051 millimeter. Striæ 15 in 0.01 millimeter. A variety closely related to var. *slesvicensis* Grunow. Sample 4.

NAVICULA ARENARIA Donkin var. ARCUATA Peragallo.

PERAGALLO, Diatom. Mar. France 101, pl. 13, figs. 4, 6.

Valve lanceolate, slightly constricted in the middle. Length, 0.044 millimeter; breadth, 0.0052 millimeter. Striæ 12 in 0.01 millimeter. Geographic distribution: France, England. Sample 5.

NAVICULA SALINARUM Grunow.

V. HEURCK, Synopsis 82, pl. 8, fig. 9.

Valve elliptic-lanceolate with protracted ends. Length, 0.032 millimeter; breadth, 0.009 millimeter. Striæ 12 in 0.01 millimeter. Geographic distribution: Spitzbergen, Sea of Kara, Finmark, Sweden, Belgium, England, Hungary (fossil). Sample 3.

NAVICULA VLADIVOSTOKENSIS sp. nov. Plate 6, fig. 17.

Valve elliptic-lanceolate, flat. Length, 0.0306 to 0.033 millimeter; breadth, 0.014 to 0.0016 millimeter. Axial area very narrow. Central area small, rounded. Median line ending close to the margin. Striæ very thin. Sample 3.

NAVICULA GRANULATA Bailey.

A. SCHMIDT, Atlas Diatom. pl. 6, figs. 26, 27.

Valve elliptic-lanceolate. Length, 0.061 millimeter; breadth, 0.03 millimeter. Striæ 10 in 0.01 millimeter, slightly radiate throughout. Geographic distribution: North, Mediterranean, and Yellow Seas, Ceylon, Sydney, California guano. Sample 3.

NAVICULA HENNEDYI Smith var. NICEAENSIS Peragallo.

PERAGALLO, Diatom. Mar. France 140, pl. 24, fig. 15.

Valve lanceolate with elongate ends. Length, 0.085 to 0.09 millimeter; breadth, 0.037 to 0.042 millimeter. Striæ 9 in 0.01 millimeter. Geographic distribution: Mediterranean Sea. Sample 5.

NAVICULA CANCELLATA Donkin var. RETUSA Brébisson. Plate 6, fig. 18.

CLEVE, Diatom. Vega Expedition pl. 36, figs. 35*a*, *b*.

Valve linear-lanceolate with rounded ends. Length, 0.056 to 0.06 millimeter; breadth, 0.009 millimeter. Axial area narrow, central broad. Median line straight. Striæ robust, 6.5 in 0.01 millimeter. Geographic distribution: Spitzbergen, North and Baltic Seas, Cape Deschneff. Sample 3.

NAVICULA DISTANS W. Smith.

CLEVE and GRUNOW, Arct. Diatom. pl. 11, fig. 42.

Valve lanceolate, gradually tapering to the ends. Length, 0.01 to 0.012 millimeter; breadth, 0.014 to 0.016 millimeter. Striæ 4.5 in 0.01 millimeter. Geographic distribution: Franz Josef Land, Spitzbergen, Finmark, Greenland, North Sea. Sample 3.

NAVICULA (SCHIZONEMA) RAMOSISSIMA Agardh.

PERAGALLO, Diatom. Mar. France pl. 12, fig. 10.

Valve linear-lanceolate with obtuse ends. Length, 0.04 millimeter; breadth, 0.006 millimeter. Striæ 15 in 0.01 millimeter. Geographic distribution: Canada, Japan, North, Caspian, and Yellow Seas. Sample 4.

NAVICULA (SCHIZONEMA) RAMOSISSIMA Agardh forma AMPLIA Grunow.

V. HEURCK, Synopsis pl. 15, fig. 3.

Valve linear-lanceolate, with obtuse ends. Length, 0.062 to 0.077 millimeter; breadth, 0.008 to 0.011 millimeter. Striæ parallel, finely lineate, 9 to 10 in 0.01 millimeter. Geographic distribution: North Sea, Canada, Mauritius. Sample 2.

NAVICULA (SCHIZONEMA) GREVILLEI Agardh. Plate 5, fig. 8.

V. HEURCK, Synopsis 110, pl. 16, fig. 2; = *N. halophila* var. *brevis* SKVORTZOW in Marin. Diatom. Dairen 423, fig. 24.

Valve rhombic-lanceolate with obtuse ends. Length, 0.045 millimeter; breadth, 0.013 millimeter. Striæ 20 in 0.01 millimeter. Geographic distribution: Spitzbergen, Finmark, coasts of England, Arctic Greenland, Cape Deschneff, West Indies, Kerguelen Land, North and Yellow Seas, California. Samples 1, 3, and 6.

DIPLONEIS BOMBUS Ehrenberg var. EGENA A. Schmidt.

A. SCHMIDT, Atlas Diatom. pl. 13, fig. 10.

Length, 0.035 millimeter; breadth, 0.015 millimeter. Striæ 10 in 0.01 millimeter. Geographic distribution: Balearic Islands, Madagascar, Manila, China, Japan. Sample 3.

DIPLONEIS PRISCA A. Schmidt var. ORIENTALIS var. nov. Plate 5, fig. 11.

Valve elliptical, very sligthly constricted in the middle, with broad rounded ends. Length, 0.047 to 0.057 millimeter; breadth, 0.0187 millimeter. Central nodule broad, quadrate. Costæ 6 in 0.01 millimeter. Samples 3 and 4.

DIPLONEIS FUSCA Gregory. Plate 5, fig. 13.

A. SCHMIDT, Atlas Diatom. pl. 7, fig. 4.

Valve elliptical. Length, 0.069 millimeter; breadth, 0.037 millimeter. Striæ 6 in 0.01 millimeter. Geographic distribution: Campeche Bay, Adriatic and North Seas, Sumatra, Balearic Islands, Hungary (fossil). Sample 3.

DIPLONEIS FUSCA Gregory var. NORVEGICA Cleve forma MINOR f. nov.

Valve elliptical with subrostrate ends and parallel margins. Length, 0.035 millimeter; breadth, 0.013 millimeter. Striæ 10

in 0.01 millimeter. Geographic distribution: The typical var. *norvegica* is found in North Sea and in Hungary (fossil). Sample 3.

DIPLONEIS FUSCA Gregory var. SUBRECTANGULARIS Cleve.

Valve rectangular. Length, 0.037 millimeter; breadth, 0.015 millimeter. Striæ 9 in 0.01 millimeter. Geographic distribution: North Sea, Balearic Islands, Sumatra. Sample 2.

DIPLONEIS SMITHII Brébisson. Plate 5, fig. 14.

A. SCHMIDT, Atlas Diatom. pl. 7, figs. 16, 17.

Valve elliptical. Length, 0.035 to 0.06 millimeter; breadth, 0.015 to 0.02 millimeter. Striæ 10 to 12 in 0.01 millimeter. Geographic distribution: A cosmopolitan diatom. Sample 2.

DIPLONEIS MAJOR Cleve. Plate 5, fig. 12.

A. SCHMIDT, Atlas Diatom. pl. 7, fig. 18.

Valve rhombic-elliptical. Length, 0.047 millimeter; breadth, 0.045 millimeter. Striæ 6 in 0.01 millimeter. Geographic distribution: North Sea, Morocco, Barcelona, Madagascar, Macassar Strait, Sumatra, China, Japan, Australia, Santa Monica, California (fossil). Sample 6.

DIPLONEIS MAJOR Cleve var. SUBCONSTRICTA var. nov. Plate 3, fig. 8.

Valve slightly constricted in the middle part. Length, 0.045 millimeter; breadth, 0.02 millimeter. Costæ 8 in 0.01 millimeter. Sample 3.

DIPLONEIS BOREALIS Grunow. Plate 5, fig. 4.

GRUNOW, Franz Josef Land Diatom. 56, pl. 1, fig. 40.

Valve robust, elongate, with rounded ends. Length, 0.047 to 0.073 millimeter; breadth, 0.02 to 0.02 millimeter. Striæ 8 to 12 in 0.01 millimeter. Geographic distribution: Franz Josef Land, Sea of Kara, Java. Sample 3.

DIPLONEIS INSCRIPTA Cleve var. JAPONICA var. nov. Plate 6, fig. 19.

Valve lanceolate, convex and acute. Length, 0.028 to 0.032 millimeter; breadth, 0.01 to 0.013 millimeter. Central pores approximate, incrassate. Striæ 18 to 20 in 0.01 millimeter, parallel. Geographic distribution: *Diploneis inscripta* is known from the Gulf of Naples and China Sea. Sample 3.

DIPLONEIS CAMPYLODISCUS Grunow.

A. SCHMIDT, Atlas Diatom. pl. 8, figs. 9–11, 12; pl. 70, figs. 64, 65.

Valve suborbicular. Length, 0.032 millimeter; breadth, 0.03 millimeter. Costæ 5 to 6 in 0.01 millimeter. Geographic dis-

tribution: Bab el Mandeb, Seychelles, Madagascar, Philippines, Tahiti, Galapagos Islands, Cape Horn, Campeche Bay. Sample 1.

STAURONEIS SALINA W. Smith.

PERAGALLO, Diatom. Mar. France pl. 7, fig. 22.

Valve lanceolate, with parallel margins and subacute ends. Stauros narrow. Length, 0.037 millimeter; breadth, 0.012 millimeter. Striæ 18 in 0.01 millimeter. Geographic distribution: North, Mediterranean, and Black Seas. Sample 4.

STAURONEIS VLADIVOSTOKENSIS sp. nov. Plate 6, figs. 20–21.

Valve elliptic-lanceolate, with obtuse ends. Length, 0.03 to 0.034 millimeter; breadth, 0.01 to 0.012 millimeter. Stauros narrower towards the margins. Striæ not seen. This peculiar species has some resemblance to *S. kryophila* Grunow in Franz Josef Land Diatom. 105, pl. 1, fig. 47. Sample 4.

CALONEIS LIBER W. Smith var. GENUINA Cleve.

A. SCHMIDT, Atlas Diatom. pl. 50, figs. 19–21, 37.

Valve linear, with slightly convex margins. Length, 0.062 millimeter; breadth, 0.012 millimeter. Striæ 22 in 0.01 millimeter. Geographic distribution: Greenland, Spitzbergen, Finmark, Bering Island, North, Mediterranean, and Yellow Seas, Ceylon, Sidney, Tasmania, Philippines, Japan, Campeche Bay. Sample 6.

CALONEIS LIBER W. Smith var. LINEARIS Grunow.

A. SCHMIDT, Atlas Diatom. pl. 50, figs. 38, 40.

Valve linear, narrow, with parallel margins. Length, 0.042 to 0.059 millimeter; breadth, 0.0085 to 0.011 millimeter. Striæ 17 in 0.01 millimeter. Geographic distribution: Atlantic coasts of Europe, Africa, and America, Peru, Honduras, Gulf of Mexico, Yellow Sea. Samples 1 and 6.

TRACHYNEIS ASPERA Ehrenberg var. GENUINA Cleve. Plate 5, fig. 7.

Valve linear-lanceolate with obtuse ends. Length, 0.111 millimeter; breadth, 0.0204 millimeter. Striæ 9 in 0.01 millimeter. Geographic distribution: Arctic America, North Sea, Cape of Good Hope, New Zealand, Samoa, New Caledonia, Java, Galapagos Islands, Sea of Japan, Vladivostok. Sample 1.

TRACHYNEIS ASPERA Ehrenberg var. MINUTA Peragallo.

PERAGALLO, Diatom. Mar. France 150–151, pl. 29, fig. 7.

Valve minute, elongate, obtuse. Length, 0.0024 millimeter; breadth, 0.011 millimeter. Striæ 18 in 0.01 millimeter. Geographic distribution: France. Sample 1.

TRACHYNEIS ASPERA Ehrenberg var. CONTERMINA A. Schmidt.

A. SCHMIDT, Atlas Diatom. pl. 48, figs. 17–18.

Valve narrow elliptical, with obtuse ends. Length, 0.054 millimeter; breadth, 0.013 millimeter. Striæ 15 in 0.01 millimeter. Geographic distribution: Sea of Japan, Cape Horn. Sample 6.

FRUSTULIA INTERPOSITA Lewis.

LEWIS, Proc. Acad. Nat. Sci. Phila. (1865) pl. 11, fig. 19.

Valve linear-elliptical, with broad, rounded ends. Length, 0.107 millimeter; breadth, 0.02 to 0.023 millimeter. Transverse striæ 25 in 0.01 millimeter. Geographic distribution: Brackish water. Sierra Leone, Bombay, California, South America, Black Sea, Hungary (fossil). Sample 6.

MASTOGLOIA ELLIPTICA Agardh.

V. HEURCK, Synopsis pl. 4, fig. 19.

Valve elliptical. Length, 0.025 millimeter; breadth, 0.012 millimeter. Striæ 18 in 0.01 millimeter. Geographic distribution: Brackish waters of Sweden, England, Belgium, and Ecuador. Sample 5.

PLEUROSIGMA ELONGATUM W. Smith var. KARIANA Grunow.

PERAGALLO, Monogr. Pleurosigma pl. 2, fig. 4.

Valves slightly sigmoid, elongated. Ends acute. Length, 0.139 millimeter; breadth, 0.015 millimeter. Transverse and oblique striæ 24/23 in 0.01 millimeter. Geographic distribution: Sea of Kara, Yellow Sea, Dairen. Sample 6.

PLEUROSIGMA SUBRIGIDUM Grunow.

PERAGALLO, Monogr. Pleurosigma pl. 2, fig. 3.

Valve linear, sigmoid, with obtuse ends. Length, 0.053 millimeter; breadth, 0.018 millimeter. Geographic distribution: North and Mediterranean Seas, Sumatra. Sample 5.

PLEUROSIGMA FORMOSUM W. Smith.

PERAGALLO, Monogr. Pleurosigma pl. 1, figs. 11–13.

Valve narrow, linear-lanceolate, sigmoid. Length, 0.2 to 0.46 millimeter; breadth, 0.02 to 0.05 millimeter. Geographic distribution: North, Mediterranean, Red, and Yellow Seas, Java, China, Bering Island, Sandwich Islands, Galapagos Islands, West Indies, Philippines, Dairen. Samples 3 and 5.

PLEUROSIGMA FORMOSUM W. Smith var. ORIENTALIS var. nov. Plate 6, fig. 30.

Valve narrow, slightly sigmoid. Length, 0.2 millimeter; breadth, 0.019 millimeter. Transverse and oblique striæ 27/25 in 0.01 millimeter. Sample 3.

PLEUROSIGMA SPECIOSUM W. Smith.

PERAGALLO, Monogr. Pleurosigma pl. 2, figs. 15–16.

Valve linear, with unilaterally rounded ends. Length, 0.27 millimeter; breadth, 0.03 millimeter. Geographic distribution: North, Mediterranean, and Red Seas, Java, Sumatra, Labuan, China, Port Jackson, Barbados. Sample 1.

PLEUROSIGMA NUBICULA W. Smith.

PERAGALLO, Monogr. Pleurosigma pl. 5, fig. 26.

Valve narrow-lanceolate, with subacute ends. Length, 0.119 millimeter; breadth, 0.017 millimeter. Transverse and oblique striæ 21 to 22 in 0.01 millimeter. Geographic distribution: Finmark, North and Adriatic Seas, Sumatra, California. Sample 1.

GYROSIGMA DISTORTUM W. Smith var. PARKERI Harrison.

PERAGALLO, Monogr. Pleurosigma pl. 8, fig. 33.

Valve lanceolate, sigmoid. Length, 0.105 millimeter; breadth, 0.0204 millimeter. Geographic distribution: England, Belgium, Baltic and Yellow Seas, Dairen. Sample 5.

PLEUROSIGMA SPENSERII W. Smith.

Valve linear-lanceolate, sigmoid, obtuse. Length, 0.093 millimeter; breadth, 0.014 millimeter. Geographic distribution: Brackish water. Spitzbergen, Sea of Kara, North Sea, Saxony, Canada, New York, West Indies, Bombay. Sample 4.

RHOICONEIS GARKEANA Grunow var. JAPONICA var. nov. Plate 6, figs. 22, 23.

Valve linear, with obtuse ends. Length, 0.04 to 0.064 millimeter; breadth, 0.01 to 0.013 millimeter. Striæ 18 in 0.01 millimeter. Geographic distribution: Typical *R. garkeana* is found in Bering Strait, Kamortha, California, North Pacific Ocean. Sample 1.

RHOICONEIS SIBIRICA Grunow.

Valve lanceolate and subacute. Length, 0.069 to 0.07 millimeter; breadth, 0.011 to 0.012 millimeter. Striæ almost parallel. Geographic distribution: Siberian Sea, Cape Wankarema. Sample 3.

RHOICOSPHENIA CURVATA Kützing.

A. SCHMIDT, Atlas Diatom. pl. 213, figs. 6, 7.

Valve clavate, with obtuse ends. Length, 0.042 millimeter; breadth, 0.0068 millimeter. Geographic distribution: Fresh and brackish waters. Baltic and Caspian Seas, Atlantic coasts of Europe and America, New Zealand, Saint Paul Island, Honduras. Sample 1.

RHOICOSPHENIA MARINA W. Smith var. JAPONICA Skvortzow.

Some Marin. Diatom. Siber. Shore (1929) 59, fig. 8.

Valve attenuate, clavate with rounded, obtuse upper ends and more narrow attenuated obtuse base. Length, 0.045 to 0.062 millimeter; breadth, 0.006 to 0.008 millimeter. Striæ 18 in 0.01 millimeter. Geographic distribution: Sea of Japan. Samples 1 and 6.

AMPHORA PROTEUS Gregory.

PERAGALLO, Diatom. Mar. France pl. 44, fig. 26.

Length, 0.039 millimeter; breadth, 0.0187 millimeter. Striæ 11 in 0.01 millimeter. Geographic distribution: Greenland, Spitzbergen, Finmark, Sea of Kara, Cape Deschneff, St. Helena, Campeche Bay, North, Mediterranean, Black, and Yellow Seas, Seychelles, China, Galapagos Islands, Dairen. Sample 3.

AMPHORA EUNOTIA Cleve var. JAPONICA var. nov. Plate 6, fig. 24.

Valve slightly curved. Length, 0.059 millimeter; breadth, 0.011 millimeter. Striæ 15 in 0.01 millimeter. Geographic distribution: Typical *A. eunotia* is known from Greenland, Spitzbergen, Bohuslan, Bab el Mandeb, Labuan. Sample 3.

AMPHORA ACUTA Gregory var. JAPONICA var. nov. Plate 6, fig. 25.

Valve lunate, with arcuate dorsal margin, slightly curved ventral side and with apiculate ends. Length, 0.073 millimeter; breadth, 0.011 millimeter. Striæ 9 in 0.01 millimeter. Ventral side striated. Sample 3.

AMPHORA ANGUSTA (Gregory) Cleve var. TYPICA Cleve forma DEPRESSA f. nov.

Valve narrow, semilanceolate, acute, slightly parallel, with depressed dorsal side. Length, 0.059 to 0.067 millimeter; breadth, 0.09 millimeter. Striæ 5.5 in 0.01 millimeter. Sample 3.

AMPHORA ANGUSTA (Gregory) Cleve var. VENTRICOSA Gregory. Plate 6, fig. 28.

CASTRACANE, Diatom. Challeng. Exped. 21, pl. 27, fig. 8.

Length, 0.079 millimeter; breadth, 0.012 millimeter. Striæ 10 in 0.01 millimeter. Geographic distribution: Greenland, Spitzbergen, Sea of Kara, Finmark, coasts of Scotland, Norway, and Bohuslan, Adriatic Sea, Bab el Mandeb, Monterey. Sample 3.

AMPHORA ANGUSTA (Gregory) Cleve var. TYPICA Cleve.

A. SCHMIDT, Atlas Diatom. pl. 25, fig. 15.

Length, 0.042 to 0.062 millimeter; breadth, 0.007 to 0.0085 millimeter. Striæ 15 to 18 in 0.01 millimeter. Geographic dis-

tribution: Scotland, Spitzbergen, Sea of Kara, Quicy, Massachusetts, Jamaica, Yellow Sea, Philippines, Hungary (fossil). Samples 5 and 6.

AMPHORA CRASSA Gregory. Plate 5, fig. 10.

A. SCHMIDT, Atlas Diatom. pl. 28, figs. 30–33.

Valve linear, with incurved ends. Length, 0.068 millimeter; breadth, 0.009 millimeter. Striæ 4.5 in 0.01 millimeter. Geographic distribution: Greenland, Spitzbergen, North Mediterranean, and Adriatic Seas, Sumatra, China, Philippines, Hungary (fossil). Sample 3.

AMPHORA MEXICANA A. Schmidt var. **MINOR** var. nov. Plate 6, fig. 26.

Valve lunate, with arcuate dorsal and straight ventral margins. Length, 0.074 millimeter; breadth, 0.01 millimeter. Median line biarcuate. Striæ 15 in 0.01 millimeter. Sample 3.

AMPHORA TURGIDA Gregory.

A. SCHMIDT, Atlas Diatom. pl. 25, figs. 24, 25.

Length, 0.042 millimeter; breadth, 0.014 millimeter. Striæ 7 in 0.01 millimeter. Geographic distribution: Scotland, Norway, Red Sea, Java, Macassar Strait, Labuan, Philippines. Sample 3.

AMPHORA OCELLATA Donkin var. **HYALINA** var. nov. Plate 6, fig. 27.

Valve linear. Central nodule on the dorsal side dilated into a stauros. Terminal fissures small. Length, 0.051 millimeter; breadth, 0.006 millimeter. Striæ very thin, 28 in 0.01 millimeter. Sample 3.

RHOPALODIA MUSCULUS Kützing.

PERAGALLO, Diatom. Mar. France pl. 77, figs. 6–8, 10.

Length, 0.034 to 0.037 millimeter. Geographic distribution: Brackish and marine waters. Sample 5.

NITSCHIA VITREA Norm.

V. HEURCK, Synopsis 181, pl. 67, figs. 10, 11.

Length, 0.093 millimeter; breadth, 0.0065 millimeter. Coarse dorsal lines 7 to 8 in 0.01 millimeter. Fine lines 25 in 0.01 millimeter. Geographic distribution: Brackish waters. North Sea. Sample 5.

NITSCHIA GRANULATA Grunow.

V. HEURCK, Synopsis pl. 57, fig. 5.

Length, 0.0185 millimeter; breadth, 0.01 millimeter. Geographic distribution: A cosmopolitan diatom. Sample 3.

NITSCHIA PUNCTATA Smith var. **COARCTATA** Grunow.

PERAGALLO, Diatom. Mar. France pl. 69, figs. 26–30.

Length, 0.035 millimeter; breadth, 0.013 millimeter. Striæ 15 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans, Yellow Sea. Sample 6.

NITSCHIA LORENZIANA Grunow.

V. HEURCK, Synopsis 185, pl. 70, fig. 12.

Length, 0.24 millimeter; breadth, 0.008 millimeter. Geographic distribution: Adriatic and North Seas. Sample 6.

NITSCHIA BILOBATA Smith var. **MINOR** Grunow.

V. HEURCK, Synopsis, pl. 60, figs. 2, 3.

Length, 0.047 millimeter; breadth, 0.013 millimeter. Fine lines 15 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans. Sample 1.

NITSCHIA JAPONICA sp. nov. Plate 6, fig. 6.

Valve lanceolate-linear, with slightly elongated and rounded ends. Length, 0.1 to 0.01 millimeter; breadth, 0.01 millimeter. Coarse dorsal lines 2.5 to 3 in 0.01 millimeter. Fine lines 28 in 0.01 millimeter. Sample 3.

NITSCHIA ANGULARIS W. Smith.

V. HEURCK, Synopsis pl. 62, figs. 11–14.

Length, 0.115 to 0.2 millimeter; breadth, 0.018 millimeter. Coarse dorsal lines 7 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans, North America, Alaska. Sample 6.

NITSCHIA SIGMA Kützing var. **HABIRSHAWII** Febiger.

V. HEURCK, Synopsis pl. 66, fig. 4.

Length, 0.35 millimeter; breadth, 0.01 millimeter. Fine lines 27 in 0.01 millimeter. Coarse dorsal lines 7 in 0.01 millimeter. Geographic distribution: North Sea, Mediterranean Sea, Yellow Sea, Dairen. Sample 1.

NITSCHIA LONGISSIMA (Brébisson) Ralfs.

A. SCHMIDT, Atlas Diatom. pl. 335, fig. 2.

Length, 0.37 to 0.39 millimeter; breadth, 0.0068 millimeter. Geographic distribution: A cosmopolitan diatom. Sample 5.

NITSCHIA ACUMINATA Smith.

V. HEURCK, Synopsis 173, pl. 58, figs. 16, 17.

Length, 0.037 millimeter; breadth, 0.005 millimeter. Fine lines 15 in 0.01 millimeter. Geographic distribution: North

America, Mediterranean and North Seas, Japan (fossil). Sample 5.

NITSCHIA APICULATA Gregory.

V. HEURCK, Synopsis pl. 58, figs. 26–27.

Valves with rostrate ends. Length, 0.059 millimeter; breadth, 0.01 millimeter. Fine lines 15 in 0.01 millimeter. Geographic distribution: North America, Mediterranean Sea. Sample 5.

NITSCHIA PANDURIFORMIS Gregory.

V. HEURCK, Synopsis pl. 58, figs. 1–3.

Valve panduriform. Length, 0.051 to 0.056 millimeter; breadth, 0.01 to 0.015 millimeter. Fine lines 25 in 0.01 millimeter. Coarse dorsal lines 10 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans, North, Mediterranean, and Yellow Seas, Philippines. Samples 2 and 3.

NITZCHIELLA CLOSTERIUM W. Smith.

SMITH, Brit. Diatom. pl. 15, fig. 120.

Valves linear-lanceolate, with long horns or beaks, curved in the one side. Length, 0.085 to 0.095 millimeter. Geographic distribution: Atlantic and Pacific Oceans. Sample 4.

GOMPHONITZSCHIA UNGERI Grunow. Plate 3, fig. 3.

Length, 0.022 to 0.034 millimeter; breadth, 0.0034 millimeter. Striæ 22 in 0.01 millimeter. Geographic distribution: Brackish waters of Egypt. Sample 1.

SURIRELLA OVALIS Brébisson.

V. HEURCK, Synopsis pl. 73, figs. 5–7.

Length, 0.03 millimeter; breadth, 0.017 millimeter. Geographic distribution: Fresh and brackish waters. A cosmopolitan diatom. Sample 5.

SURIRELLA FASTUOSA Ehrenberg var. CUNEATA Grunow.

A. SCHMIDT, Atlas Diatom. pl. 4, figs. 1, 2.

Length, 0.072 to 0.08 millimeter; breadth, 0.045 to 0.054 millimeter. Geographic distribution: A cosmopolitan marine diatom. Samples 1 and 6.

CAMPYLODISCUS SAMOENSIS Grunow.

A. SCHMIDT, Atlas Diatom. pl. 15, figs. 13, 15, 18, 20.

Diameter of the valve 0.102 millimeter. Costæ 3 to 4 in 0.01 millimeter. Geographic distribution: Mediterranean and Yellow Seas, Pacific Ocean, Philippines. Sample 1.

ILLUSTRATIONS

PLATE 1

FIG. 1. *Hyalodiscus ambiguus* Grunow.
FIGS. 2 and 3. *Stephanopyxis turris* (Greville and Arn.) Ralfs var. *intermedia* Grunow.
4 and 5. *Cyclotella striata* (Kützing) Grunow var. *ambigua* Grunow.
6 to 9. *Cyclotella striata* (Kützing) Grunow.

PLATE 2

FIG. 1. *Coscinodiscus marginatus* Ehrenberg.
FIGS. 2 to 4. *Coscinodiscus radiatus* Ehrenberg.
5 and 6. *Coscinodiscus denarius* A. Schmidt.
FIG. 7. *Coscinodiscus curvatulus* Grunow var. *japonica* var. nov.
8. *Coscinodiscus lineatus* Ehrenberg.
9. *Coscinodiscus curvatulus* Grunow var. *minor* (Ehrenberg) Grunow.

PLATE 3

FIG. 1. *Actinoptychus undulatus* (Bailey) Ralfs.
2. *Coscinodiscus excentricus* Ehrenberg.
3. *Gomphonitzschia ungeri* Grunow.
4. *Asteromphalus heptactis* (Brébisson) Ralfs.
5. *Aulacodiscus amoenus* Greville.
6. *Auliscus coelatus* Bailey var. *strigillata* A. Schmidt.
7. *Cocconeis scutellum* Ehrenberg var. *japonica* Skvortzow.
8. *Diploneis major* Cleve var. *subconstricta* var. nov.
9. *Biddulphia aurita* Brébisson.
10. *Cocconeis dirupta* Gregory var. *antarctica* Grunow.
11. *Cocconeis scutellum* Ehrenberg var. *ornata* Grunow.

PLATE 4

FIGS. 1 to 8. *Cocconeis scutellum* Ehrenberg var. *japonica* Skvortzow.

PLATE 5

FIG. 1. *Cocconeis dirupta* Gregory var. *sigma* Pantocsek.
2. *Cocconeis heteroidea* Hantsch.
3. *Rhabdonema arcuatum* (Lyngbye) Kützing.
4. *Diploneis borealis* Grunow.
5. *Pinnularia quadratarea* A. Smith var. *undulata* var. nov.
6. *Navicula forcipata* Greville var. *densestriata* A. Smith.
7. *Trachyneis aspera* Ehrenberg var. *genuina* Cleve.
8. *Navicula (Schizonema) grevillei* Agardh.
9. *Navicula lyra* Ehrenberg var. *intermedia* Peragallo.
10. *Amphora crassa* Gregory.

FIG. 11. *Diploneis prisca* A. Smith var. *orientalis* var. nov.
12. *Diploneis major* Cleve.
13. *Diploneis fusca* Gregory.
14. *Diploneis smithii* Brébisson.

PLATE 6

FIG. 1. *Licmophora gracilis* (Kützing) Ehrenberg.
2. *Licmophora communis* (Heib.) Grunow.
3. *Biddulphia aurita* Brébisson.
4. *Biddulphia aurita* Brébisson var. *orientalis* Mereschkovski.
5. *Grammatophora angulosa* Ehrenberg.
6. *Nitschia japonica* sp. nov.
7. *Licmophora lyngbyei* Kützing var. *elongata* Grunow.
8. *Fragilaria oceanica* Cleve var. *acuta* var. nov.
9. *Fragilaria oceanica* Cleve var. *japonica* var. nov.
10. *Biddulphia obtusa* Grunow.
11. *Grammatophora angulosa* Ehrenberg var. *islandica* Ehrenberg.
12. *Navicula lyra* Ehrenberg var. *subelliptica* Cleve forma.
13. *Pinnularia claviculus* Gregory var. *japonica* var. nov.
14. *Synedra affinis* Kützing var. *hybrida* Grunow.
15. *Synedra affinis* Kützing var. *tabulata* Grunow.
16. *Navicula viridula* Kützing var. *japonica* var. nov.
17. *Navicula vladivostokensis* sp. nov.
18. *Navicula cancellata* Donkin var. *retusa* Brébisson.
19. *Diploneis inscripta* Cleve var. *japonica* var. nov.

FIGS. 20 and 21. *Stauroneis vladivostokensis* sp. nov.
22 and 23. *Rhoiconeis garkeana* Grunow var. *japonica* var. nov.

FIG. 24. *Amphora eunotia* Cleve var. *japonica* var. nov.
25. *Amphora acuta* Gregory var. *japonica* var. nov.
26. *Amphora mexicana* A. Smith var. *minor* var. nov.
27. *Amphora ocellata* Donkin var. *hyalina* var. nov.
28. *Amphora angusta* (Gregory) Cleve var. *ventricosa* Gregory.
29. *Cocconeis heteroidea* Hantsch.
30. *Pleurosigma formosum* Smith var. *orientalis* var. nov.

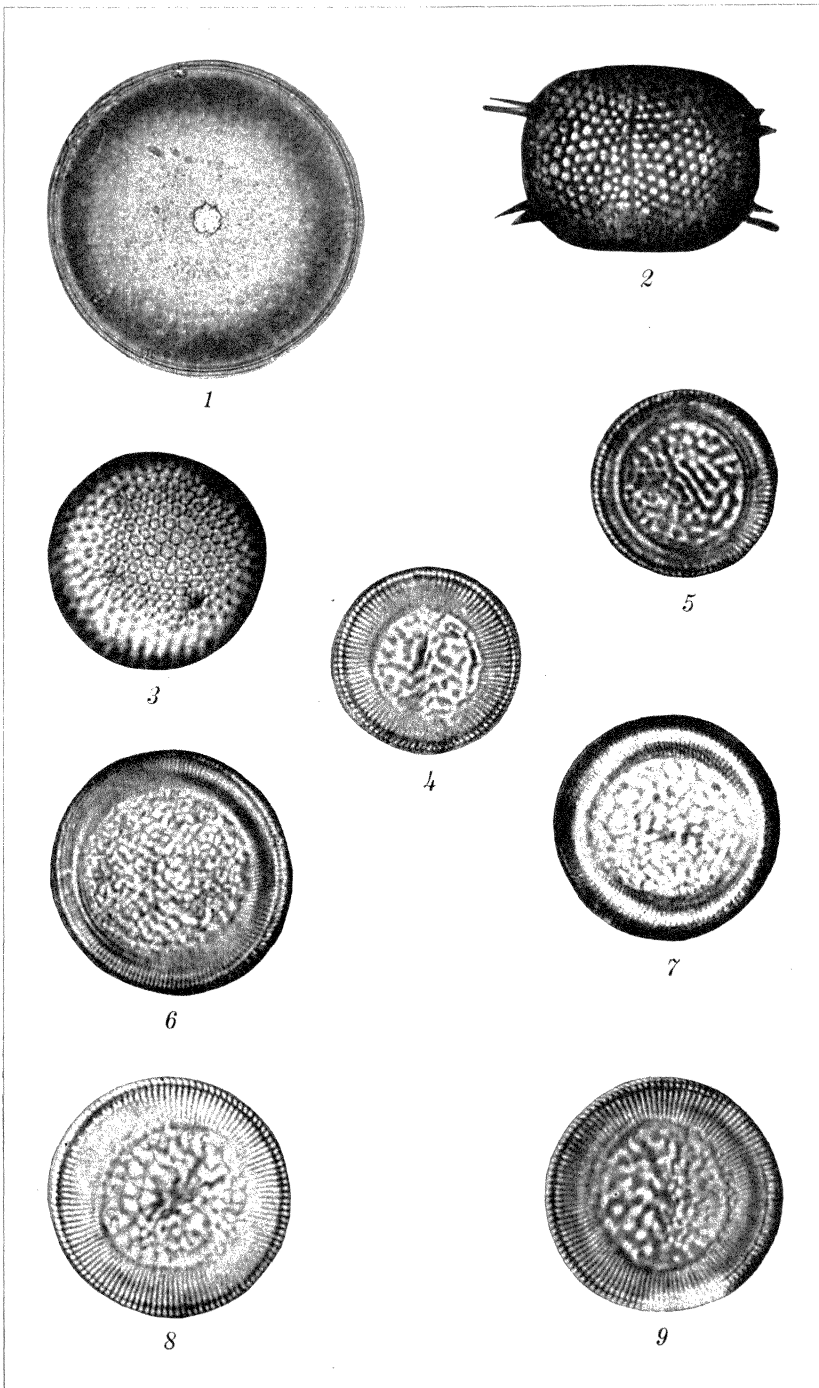


PLATE 1.

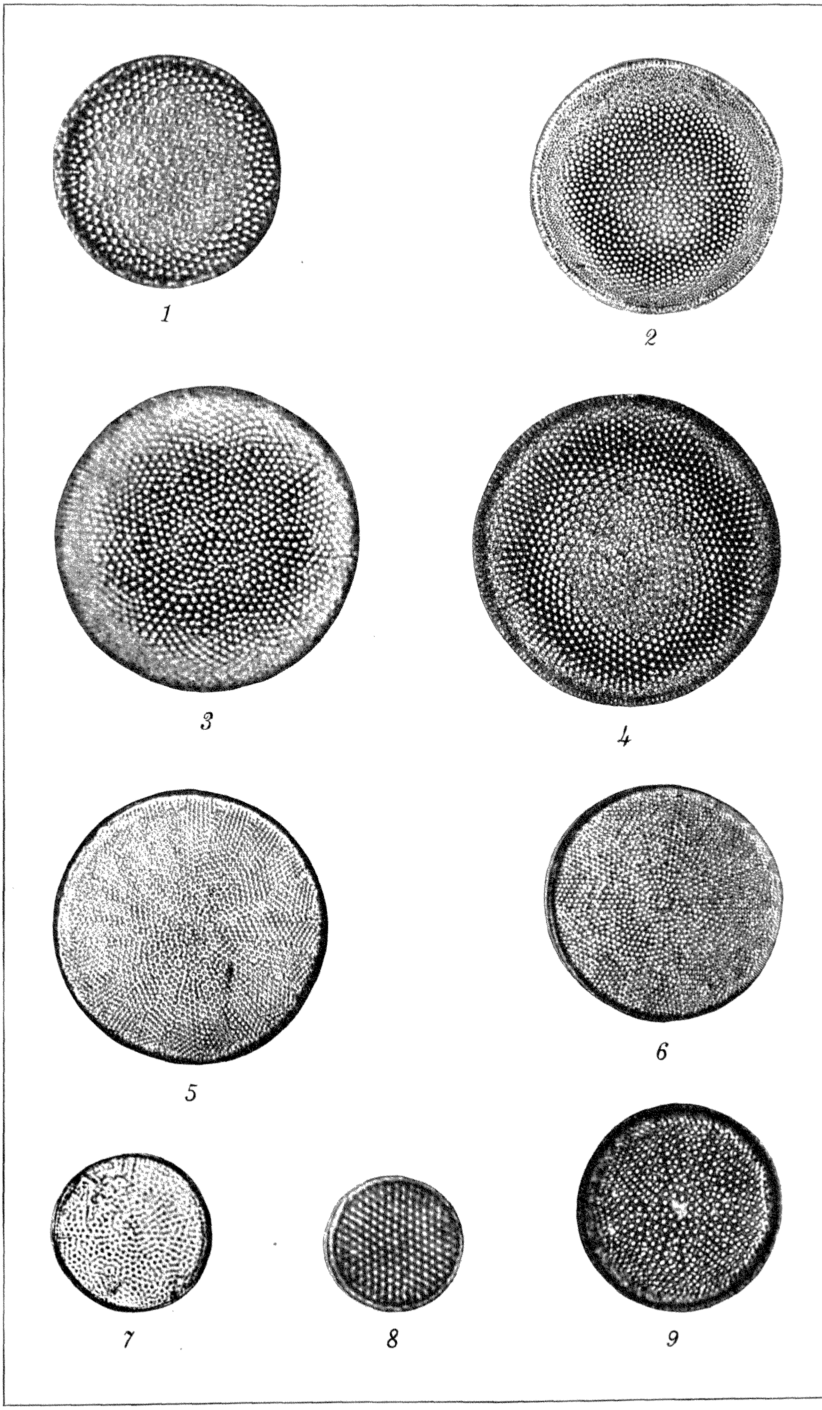


PLATE 2.

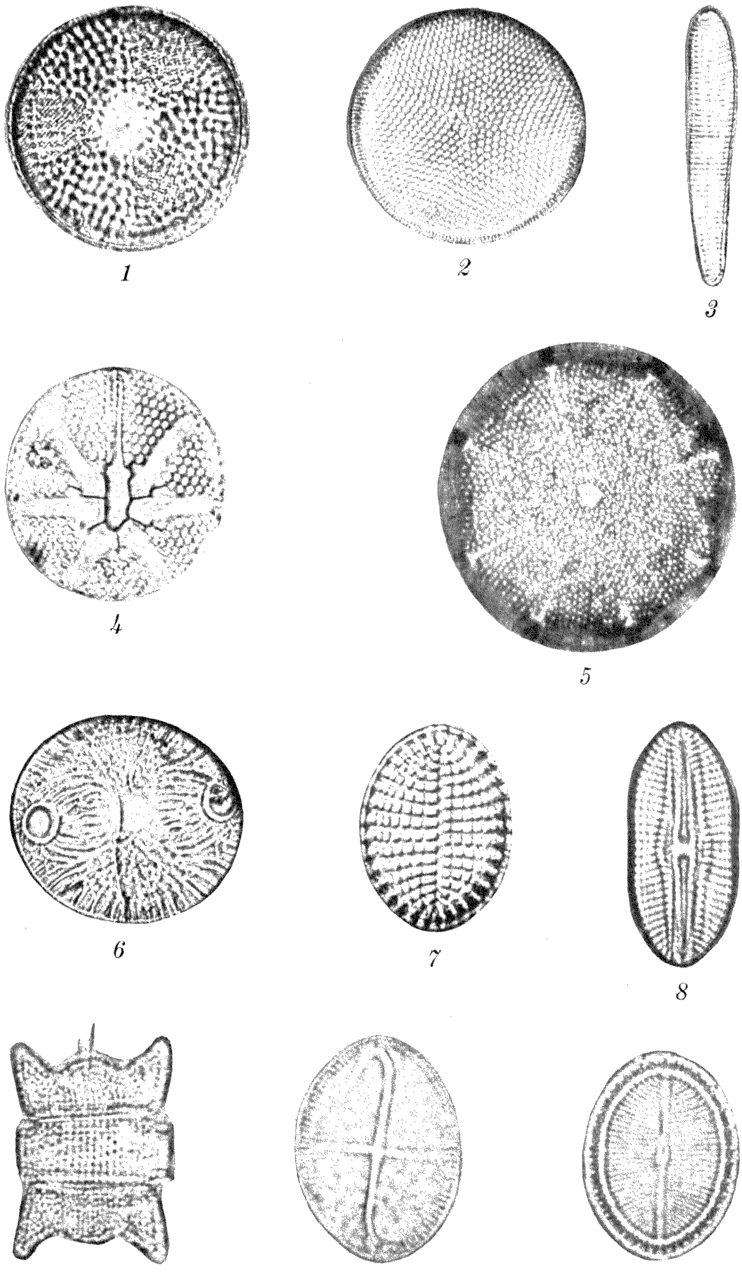


PLATE 3.

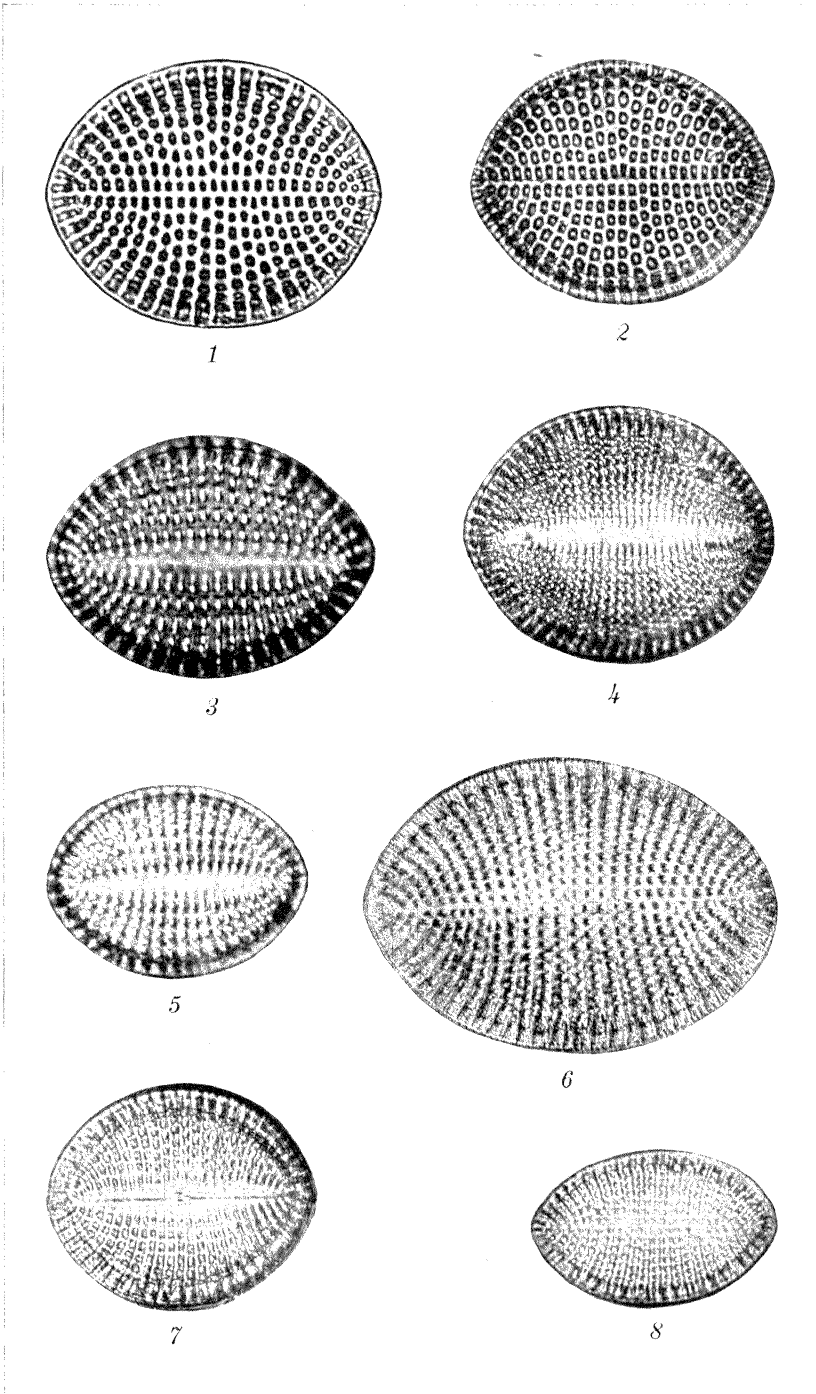


PLATE 4.

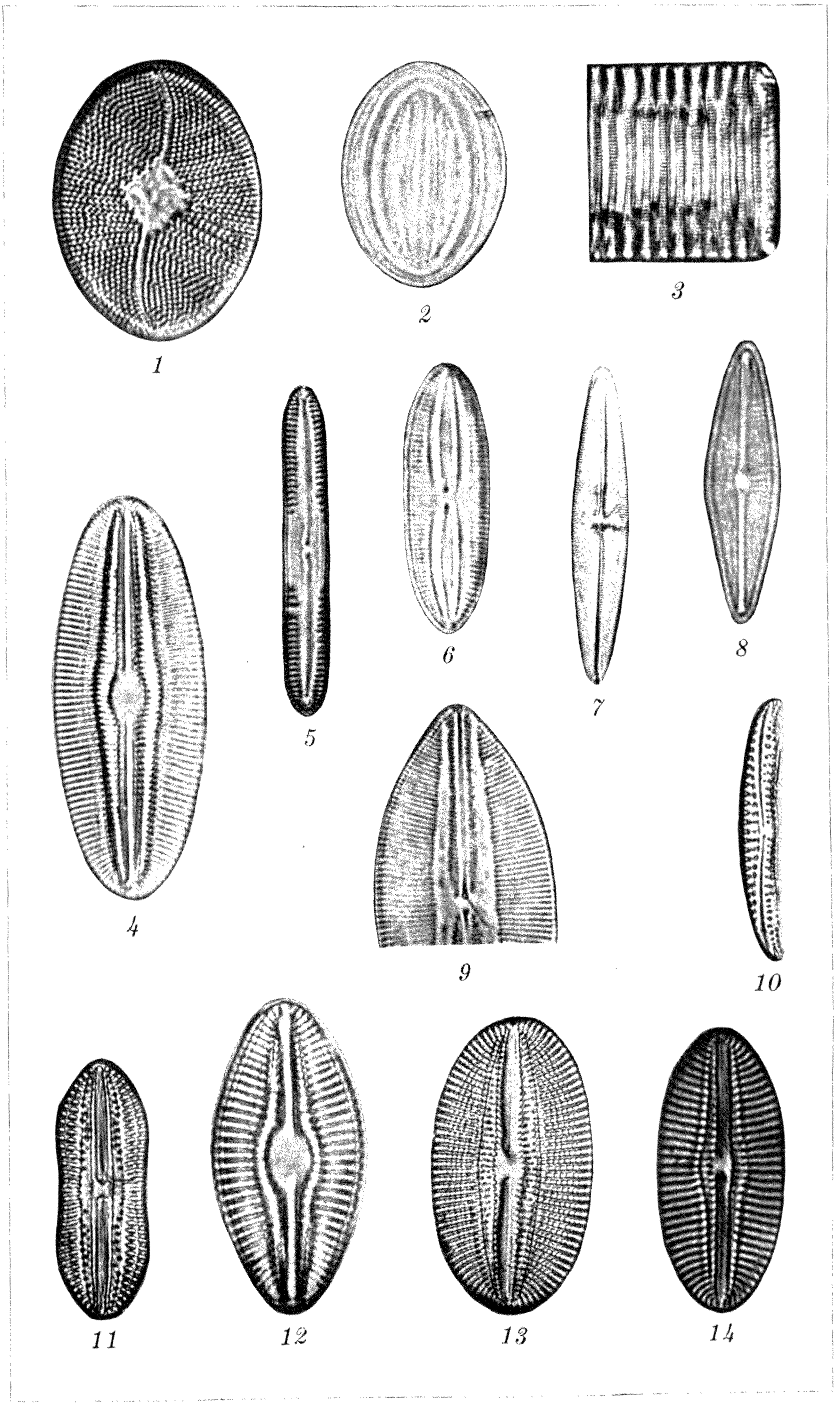
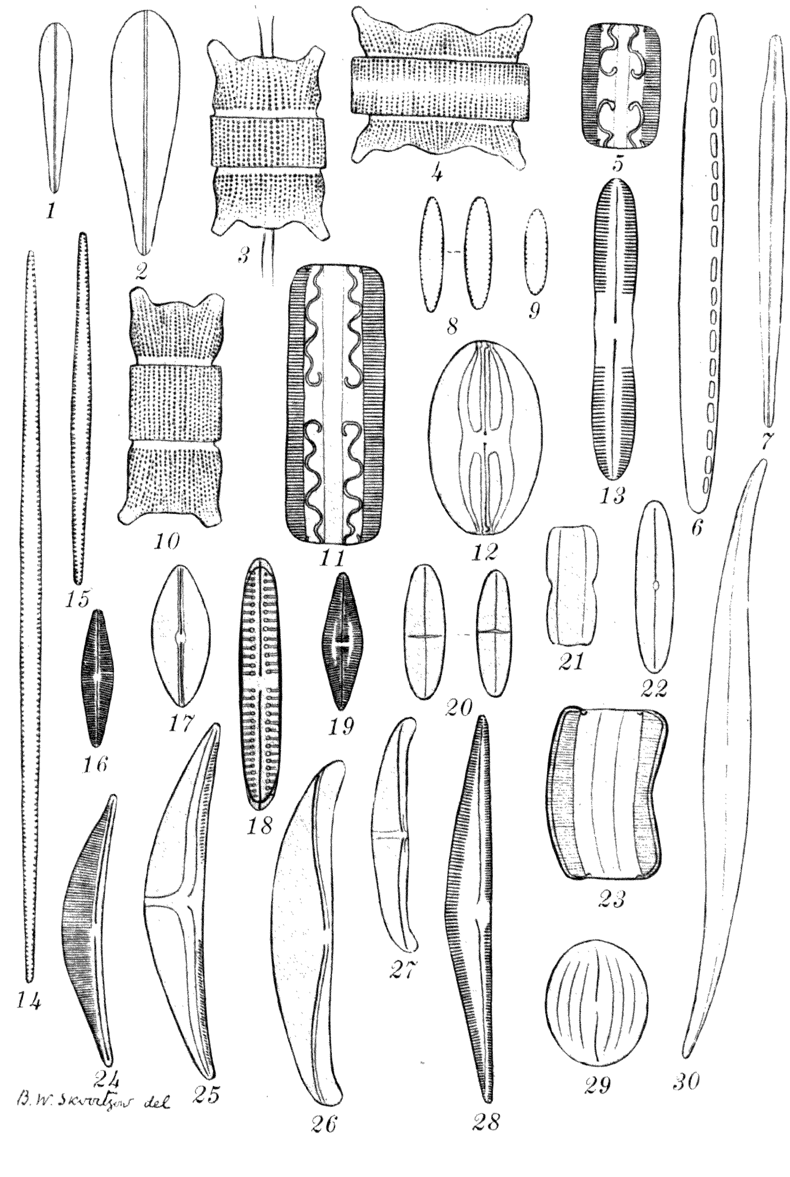


PLATE 5.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B. W. Skvortzow del.

PLATE 6.

MARINE DIATOMS FROM FORMOSA STRAIT

By B. W. SKVORTZOW

Of Harbin, China

THREE PLATES

The material that is reported upon in the following pages was collected by me on the seashore of Fukien Province, near Foochow, China, during the winter of 1918. The material consisted of several samples of marine Cladophoraceæ and Laminariaceæ on the twigs of which I have found quite a number of diatoms. These algæ have been examined from a systematic point of view, and twenty-six genera, including sixty-four species and varieties, were recorded. I am describing ten species and varieties as new. In order to show the geographical significance of the diatoms found at Foochow, reference is given to the previously recorded geographical distribution of each species. These records indicate a very wide range of localities for many of our types, while on the other hand some species are peculiar to the southern part of the Pacific.

MELOSIRA NUMMULOIDES (Dillw.) Agardh.

V. HEURCK, Synopsis pl. 85, figs. 1, 2.

Length, 0.017 millimeter; breadth, 0.015 millimeter. Geographic distribution: Atlantic and Pacific Oceans.

MELOSIRA MONILIFORMIS (Müller) Agardh.

V. HEURCK, Synopsis pl. 85, figs. 5–7.

Valve brown, dotted. Breadth, 0.048 to 0.05 millimeter. Geographic distribution: Pacific Ocean, North and Mediterranean Seas.

PODOSIRA STELLIGER (Bailey) Mann.

V. HEURCK, Synopsis pl. 84, figs. 1–2.

Diameter of the valve 0.068 to 0.07 millimeter. Geographic distribution: Atlantic and Pacific Oceans.

HYALODISCUS AMBIGUUS Grunow.

PERAGALLO, Diatom. Mar. France pl. 119, fig. 19.

Diameter of the valve 0.15 to 0.17 millimeter. Striæ 22 in 0.01 millimeter. Geographical distribution: North and Mediterranean Seas.

COSCINODISCUS CENTRALIS Ehrenb.

HUSTEDT, F. Die Kiesel algen. Lief. 3, p. 444–45, fig. 243.

Diameter of the valve 0.2 to 0.25 millimeter. Markings 4 to 5 in 0.01 millimeter. Geographic distribution: Pacific and Atlantic Oceans, China, North Sea.

COSCINODISCUS WEYPRECHTI Grunow.

GRUNOW, Diatom. Franz Josef Land 78, pl. C, fig. 8.

Central space minute, with a small rosette. Markings gradually decreasing outwards; towards the center 4.5 to 5, towards the border 5.5 to 6.5, in 0.01 millimeter. Marking with central dot and minute puncta. Border with delicate striæ. Geographic distribution: Franz Josef Land, North Sea.

COSCINODISCUS RADIATUS Ehrenberg.

A. SCHMIDT, Atlas Diatom. pl. 60, figs. 1–6, 9, 10; pl. 61, fig. 13; pl. 65, fig. 8.

Diameter of the valve 0.075 to 0.01 millimeter. Markings 4 to 5 in 0.01 millimeter. Geographic distribution: A cosmopolitan diatom.

COSCINODISCUS DENARIUS Schmidt.

A. SCHMIDT, Atlas Diatom. pl. 57, figs. 19–21.

Diameter of the valve 0.069 to 0.095 millimeter. Markings 6 in 0.01 millimeter. Geographic distribution: Atlantic Ocean.

COSCINODISCUS OCULUS IRIDIS Ehrenberg.

A. SCHMIDT, Atlas Diatom. pl. 63, figs. 6, 7, 9.

Diameter of the valve 0.2 millimeter. Geographic distribution: A cosmopolitan diatom.

COSCINODISCUS EXCENTRICUS Ehrenberg.

A. SCHMIDT, Atlas Diatom. pl. 58, figs. 46–49.

Diameter of the valve 0.068 to 0.075 millimeter. Markings 4 to 5 in 0.01 millimeter. Geographic distribution: Pacific Ocean, North and Yellow Seas, Japan, Philippine Islands.

COSCINODISCUS LINEATUS Ehrenberg.

A. SCHMIDT, Atlas Diatom. pl. 59, figs. 29–31.

Diameter of the valve 0.044 millimeter. Markings 2.5 in 0.01 millimeter. Geographic distribution: A cosmopolitan diatom.

ACTINOPTYCHUS UNDULATUS (Bail.) Ralfs.

V. HEURCK, Synopsis pl. 122, figs. 1, 3.

Diameter of the valve 0.034 to 0.04 millimeter. Geographic distribution: Atlantic and Pacific Oceans.

ACTINOPTYCHUS ANNULATUS (Wallich) Grunow var. **MINOR** Grunow. Plate 1, fig. 7.

V. HEURCK, Synopsis pl. 124, fig. 13.

Diameter of the valve 0.042 to 0.062 millimeter. Geographic distribution. Pacific Ocean, China.

ACTINOCYCLUS EHRENBERGI Ralfs var. **CRASSA** (W. Smith) Hustedt.

V. HEURCK, Synopsis pl. 124, figs. 6, 8.

Diameter of the valve 0.057 to 0.085 millimeter. Markings 6 in 0.01 millimeter. Geographic distribution: Pacific Ocean.

ARACHNOIDISCUS ORNATUS Ehrenberg.

A. SCHMIDT, Atlas Diatom. pl. 73, figs. 4–10.

Diameter of the valve 0.04 to 0.085 millimeter. Geographic distribution: Japan, Honshu Islands, Yokohama.

BIDDULPHIA OBTUSA Grunow. Plate 2, figs. 11, 12.

A. SCHMIDT, Atlas Diatom. pl. 122, figs. 31, 30.

Length, 0.025 to 0.06 millimeter; breadth, 0.018 to 0.065 millimeter. Geographic distribution: North Sea, China, New York, Carpentaria Bay.

BIDDULPHIA GRUNDLERI A. Schmidt. Plate 1, fig. 11; Plate 2, figs. 2, 3.

A. SCHMIDT, Atlas Diatom. pl. 118, figs. 22–24.

Length, 0.111 to 0.14 millimeter; breadth, 0.02 to 0.042 millimeter. Geographic distribution: Sea of Japan, China, Philippines, Adriatic Sea.

BIDDULPHIA ARCTICUM (Brightwell) Cleve var. **FORMOSA** Brightwell. Plate 1, fig. 4.

A. SCHMIDT, Atlas Diatom. pl. 79, fig. 2.

Diameter of the valve 0.07 to 0.08 millimeter; puncta 4 to 6 in 0.01 millimeter. Geographic distribution: North Sea, Sea of Japan, Samoa, Philippine Islands.

BIDDULPHIA CONCAVA Mann. Plate 2, fig. 5.

A. SCHMIDT, Atlas Diatom. pl. 84, fig. 17.

Diameter of the valve 0.073 millimeter. Geographic distribution: Sea of Japan, Philippine Islands.

CYCLOTELLA STYLORUM Brightwell.

V. HEURCK, Synopsis pl. 92, figs. 2-4.

Diameter of the valve 0.042 to 0.05 millimeter. Striæ 9 in 0.01 millimeter. The border markings 4 in 0.01 millimeter. Geographic distribution: North and Mediterranean Seas, Sea of Japan.

CYCLOTELLA STRIATA (Kützing) Grunow var. **INTERMEDIA** Grunow.

V. HEURCK, Synopsis pl. 92, fig. 10.

Diameter of the valve 0.0198 to 0.02 millimeter. Striæ 12 in 0.01 millimeter. Geographic distribution: North Sea, Pacific Ocean, Sea of Japan.

BACTERIASTRUM HYALINUM Lauder.

IKARI, Bacteriastrum Japan 422, 23, fig. 2.

Valves 0.014 to 0.018 millimeter in breadth. Geographic distribution: Atlantic and Pacific Oceans, Sea of Japan, Korean Strait.

GRAMMATOPHORA ANGULOSA Ehrenberg var. **HAMULIFERA** Kützing. Plate 2, fig. 7.

V. HEURCK, Synopsis pl. 53, fig. 4.

Length and breadth, 0.017 millimeter. Striæ 15 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans.

GRAMMATOPHORA MARINA (Lyngbye) Kützing var. **UNDULATA** Ehrenberg.

V. HEURCK, Synopsis pl. 53, fig. 17.

Length, 0.051 to 0.12 millimeter; breadth, 0.017 to 0.025 millimeter. Geographic distribution: Mediterranean and North Seas, Japan, China.

GRAMMATOPHORA MARINA (Lyngbye) Kützing.

V. HEURCK, Synopsis 163, pl. 53, fig. 10.

Length, 0.074 millimeter; breadth, 0.01 millimeter. Geographic distribution: A cosmopolitan diatom.

RHABDONEMA ADRIATICUM Kützing.

A. SCHMIDT, Atlas Diatom. pl. 217, figs. 17–29.

Length, 0.113 to 0.12 millimeter. Geographic distribution: Atlantic Ocean, Mediterranean and Red Seas, Australia.

SYNEDRA ROBUSTA Ralfs var. **SINICA** var. nov. Plate 1, fig. 9.

Valve lanceolate with rounded ends. Length, 0.17 to 0.19 millimeter; breadth, 0.017 to 0.02 millimeter. Lines 6 in 0.01 millimeter.

RHAPHONEIS ELLIPTICA Castracane.

CASTRACANE, Challenger Diatom. 49, pl. 26, fig. 13.

Valve elliptical, acute. Length, 0.074 to 0.084 millimeter; breadth, 0.026 to 0.04 millimeter. Costæ 4 to 6 in 0.01 millimeter. Geographic distribution: Sea of Japan.

COCCONEIS PELTA A. Schmidt var. SINICA var. nov. Plate 2, fig. 4.

Valve broad elliptical. Length, 0.012 millimeter; breadth, 0.0065 millimeter. Striæ 12 in 0.01 millimeter. Typical *Cocconeis pelta* is known from the North Sea.

COCCONEIS GREVILLEI W. Smith var. TYPICA Cleve. Plate 1, fig. 8.

V. HEURCK, Synopsis pl. 28, figs. 10, 11.

Valve broad elliptical with rounded ends. Length, 0.33 millimeter; breadth, 0.027 millimeter. Geographic distribution: New Zealand, Galapagos and Sandwich Islands, Japan, Ceylon, West Indies, English Channel.

ACHNANTHES BREVIPES Agardh var. INTERMEDIA Kützing.

V. HEURCK, Synopsis 129, pl. 26, figs. 21–24.

Valve linear-elliptical. Length, 0.035 to 0.044 millimeter; breadth, 0.009 to 0.01 millimeter. Striæ 10 to 12 in 0.01 millimeter. Geographic distribution: Brackish and marine waters. Finmark, coasts of Britain, North, Baltic, Caspian, and Mediterranean Seas, Amsterdam Islands.

ACHNANTHES BREVIPES Agardh var. JAPONICA var. nov. Plate 2, fig. 9.

Valve elongate-linear-elliptical. Length, 0.091 millimeter; breadth, 0.014 millimeter. Striæ 10 in 0.01 millimeter. Geographic distribution: Sea of Japan.

ACHNANTHES BREVIPES Agardh var. LEUDUGERI Tempere and Brun. Plate 2, fig. 13.

TEMPERE and BRUN, Diatom. fossil. Japon. 9, pl. 9, fig. 11; = *Achnanthes kerguelensis* CASTRACANE in Voy. Challenger, 41, pl. 20, fig. 15.

Valve broadly lanceolate with obtuse ends. Length, 0.042 millimeter; breadth, 0.017 millimeter. Striæ 8 to 10 in 0.01 millimeter. Geographic distribution: North Sea, Kerguelen Land, Japan (fossil).

NAVICULA BRASILIENSIS Grunow. Plate 1, fig. 6.

A. SCHMIDT, Atlas Diatom. pl. 6, figs. 19–25, 31–33.

Valve lanceolate with slightly subrostrate ends. Length, 0.115 millimeter; breadth, 0.035 millimeter. Striæ 10 in 0.01 millimeter. Geographic distribution: Atlantic coast of North America, West Indies, Campeche Bay, Brazil, Bab el Mandeb, Zanzibar, Madagascar, Ceylon, Singapore, Labuan, China, Japan, New Caledonia, Samoa, Sandwich Islands.

NAVICULA SCOPULORUM Brébisson.

V. HEURCK, Synopsis 99, Suppl. B, fig. 28.

Valve linear with broad rounded ends. The middle part and the end of the valve are slightly gibbous. Length, 0.14 milli-

meter; breadth, 0.012 millimeter. Striæ 18 to 20 in 0.01 millimeter. Geographic distribution: Brackish water. South coasts of England, Mediterranean and Adriatic Seas, Sumatra, Labuan, Japan, East Cape, North Siberia, Brazil.

NAVICULA (SCHIZONEMA) MOLLIS W. Smith.

V. HEURCK, Synopsis pl. 15, figs. 22, 23.

Valve lanceolate, obtuse. Length, 0.03 millimeter; breadth, 0.007 millimeter. Striæ 15 in 0.01 millimeter. Geographic distribution: Arctic America, Cape Sabine, Bohuslan, North and Adriatic Seas.

NAVICULA (SCHIZONEMA) RAMOSISSIMA Agardh var. SETACEUM Kützing.

V. HEURCK, Synopsis 111, pl. 15, fig. 13.

Valve narrow linear-lanceolate with subrostrate end. Length, 0.034 millimeter; breadth, 0.005 millimeter. Striæ parallel, 18 in 0.01 millimeter. Geographic distribution: North Sea.

DIPLONEIS SMITHII Brébisson.

A. SCHMIDT, Atlas Diatom. pl. 7, figs. 16, 17.

Valve elliptical. Length, 0.047 millimeter; breadth, 0.02 millimeter. Striæ 9 in 0.01 millimeter. Geographic distribution: Franz Josef Land, Spitzbergen, Sea of Kara, Finmark, Gulf of Bothnia, Baltic, North, and Mediterranean Seas, Madagascar, Seychelles, Tasmania, Java, New Zealand, Colon, Campeche Bay.

FRUSTULIA LEWISIANA Greville. Plate 2, fig. 16.

GREVILLE, T. M. S. II, p. 15, pl. 1, fig. 7.

Valve linear with parallel margins and broad rounded ends. Length, 0.102 to 0.17 millimeter; breadth, 0.017 to 0.03 millimeter. Geographic distribution: Brackish water. Sierra Leone, Cameroon, India, Batavia, Sendai, Japan (fossil), Brazil, Florida, Georgia.

FRUSTULIA INTERPOSITA Lewis var. CHINENSIS var. nov. Plate 2, fig. 15.

Valve linear with parallel margins and broad rounded ends. Length, 0.068 millimeter; breadth, 0.008 millimeter. Transverse striæ about 24, longitudinal 18 to 20 in 0.01 millimeter. Geographic distribution: The typical form is known in brackish waters of America.

TRACHYNEIS ASPERA Ehrenberg var. CHINENSIS var. nov. Plate 2, fig. 6.

Valve linear-lanceolate, obtuse, asymmetrical. Length, 0.107 millimeter; breadth, 0.03 millimeter. Axial area broad, unilateral. Central area also broad in one side with a stauros. Al-

veoli forming transverse striæ, radiate throughout, 8 in 0.01 millimeter in more or less oblique rows.

TRACHYNEIS ASPERA Ehrenberg var. **PULCHELLA** W. Smith. Plate 2, fig. 14.

A. SCHMIDT, Atlas Diatom. pl. 48, figs. 12, 13.

Valve elliptic with obtuse ends. Length, 0.064 millimeter; breadth, 0.03 millimeter. Striæ 8 in 0.01 millimeter. Geographic distribution: North Sea, Philippine Islands, Samoa, Sandwich Islands.

PLEUROSIGMA ELONGATUM W. Smith var. **SINICA** var. nov. Plate 3, fig. 2.

Valve sigmoid, elongate, gradually attenuate to the acute ends. The middle part of the valve slightly undulate. Length, 0.2 millimeter; breadth, 0.025 millimeter. Transverse and oblique striæ 20/18 in 0.01 millimeter.

PLEUROSIGMA ANGULATUM Quekett. Plate 3, fig. 9.

PERAGALLO, Monogr. Pleurosigma pl. 5, fig. 3.

Valve rhomboidal-lanceolate, slightly angular in the middle. Length, 0.195 millimeter; breadth, 0.04 millimeter. Geographic distribution: North Sea, Barbados.

PLEUROSIGMA LONGUM Cleve var. **INFLATA** Peragallo. Plate 3, fig. 4.

PERAGALLO, Monogr. Pleurosigma pl. 1, fig. 10.

Valve lanceolate, sigmoid with acute ends. Length, 0.03 millimeter; breadth, 0.034 millimeter. Geographic distribution: Mediterranean Sea.

GYROSIGMA DISTORTUM W. Smith. Plate 3, fig. 3.

PERAGALLO, Monogr. Pleurosigma pl. 8, fig. 32.

Valve lanceolate, slightly sigmoid. Length, 0.088 millimeter; breadth, 0.02 millimeter. Geographic distribution: Spitzbergen, North Sea, English Channel, Jonian Archipelago, Cameroon, Africa.

GYROSIGMA SPENCERII W. Smith var. **ACUTIUSCULA** Grunow (?). Plate 3, fig. 8.

PERAGALLO, Monogr. Pleurosigma pl. 8, fig. 32.

Valve lanceolate, slightly sigmoid. Length, 0.061 millimeter; breadth, 0.01 millimeter. Geographic distribution: Fresh water. Sweden, Finland, Belgium, Saxony, East Indies, Japan, Tasmania, New Zealand, North America.

GYROSIGMA GROVEI Cleve. Plate 3, fig. 6.

PERAGALLO, Monogr. Pleurosigma pl. 8, fig. 1.

Valve linear, sigmoid at the attenuated, obliquely rounded ends. Length, 0.034 millimeter; breadth, 0.032 millimeter. Geographic distribution: Brackish water. Java, Singapore.

GYROSIGMA SCALPROIDES Rabenhorst var. EXIMIA Thw. Plate 3, fig. 7.

PERAGALLO, Monogr. Pleurosigma pl. 8, fig. 47.

Valve linear with broad rounded ends. Length, 0.079 to 0.085 millimeter; breadth, 0.01 to 0.013 millimeter. Striæ 20/24 in 0.01 millimeter. Geographic distribution: Fresh water. Sweden, England, Belgium, Bengal.

GYROSIGMA FASCIOLA Ehrenberg var. TENUIROSTRIS Grunow. Plate 3, fig. 5.

PERAGALLO, Monogr. Pleurosigma pl. 8, fig. 42.

Valve lanceolate, slightly sigmoid with long beaks. Length, 0.105 millimeter; breadth, 0.009 millimeter. Geographic distribution: Seas of Kara and Japan.

AMPHORA ANGUSTA (Gregory) Cleve var. CHINENSIS var. nov. Plate 2, fig. 10.

Valve gibbous in the middle with capitate ends. Length, 0.04 millimeter; breadth, 0.01 millimeter. Striæ 18 in 0.01 millimeter. A form related to var. *diducta* A. Schmidt, Atlas Diatom. pl. 28, figs. 8, 13.

RHOPALODIA MUSCULUS Kützing var. CONSTRICTA W. Smith.

PERAGALLO, Diatom. Mar. France pl. 77, figs. 11–17.

Length, 0.025 to 0.042 millimeter; breadth, 0.02 millimeter. Geographic distribution: Brackish and marine waters.

NITSCHIA MAXIMA Grunow.

V. HEURCK, Synopsis pl. 65, fig. 1, 2.

Length, 0.77 millimeter; breadth, 0.025 millimeter. Costæ 4 to 5 in 0.01 millimeter. Geographic distribution: Adriatic Sea.

NITSCHIA SIGMA Kützing var. SIGMATELLA (Gregory) Grunow.

V. HEURCK, Synopsis pl. 66, figs. 6, 7.

Length, 0.0272 to 0.03 millimeter; breadth, 0.0085 millimeter. Coarse lines 7 to 8 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans.

NITSCHIA OBTUSA W. Smith.

A. SCHMIDT, Atlas Diatom. pl. 336, figs. 20–21.

Length, 0.115 millimeter; breadth, 0.006 millimeter. Fine lines 30 in 0.01 millimeter. Geographic distribution: Brackish water.

NITSCHIA OBTUSA W. Smith var. BREVISSIMA Grunow.

V. HEURCK, Synopsis, pl. 67, fig. 4.

Length, 0.059 to 0.069 millimeter; breadth, 0.005 to 0.006 millimeter. Costæ 8 in 0.01 millimeter. Geographic distribution: Brackish water.

NITSCHIA LORENZIANA Grunow var. **SUBTILIS** Grunow.

A. SCHMIDT, Atlas Diatom. pl. 335, figs. 6–8.

Length, 0.081 millimeter; breadth, 0.0042 millimeter. Striæ 15 in 0.01 millimeter. Geographic distribution: North and Mediterranean Seas, Ceylon.

NITSCHIA LANCETTULA O. Müller var. **CHINENSIS** var. nov. Plate 2, fig. 8.

Valve lanceolate with acute noncapitate ends. Length, 0.028 to 0.03 millimeter; breadth, 0.0068 to 0.0075 millimeter. Lines of puncta 12 in 0.01 millimeter. Coarse lines 5 to 6 in 0.01 millimeter. The typical form of *N. lancettula* is known from Tanganyika Lake, Africa.

NITSCHIA SOCIALIS Gregory.

PERAGALLO, Diatom. Mar. France pl. 72, fig. 8.

Length, 0.08 millimeter; breadth, 0.007 millimeter. Fine lines 18 to 20 in 0.01 millimeter. Coarse dorsal lines 7 in 0.01 millimeter. Geographic distribution: Adriatic Sea.

NITSCHIA MACILENTA Gregory forma **ABBREVIATA** Grunow.

PERAGALLO, Diatom. Mar. France pl. 72 fig. 2.

Length, 0.127 to 0.135 millimeter; breadth, 0.0068 to 0.008 millimeter. Geographic distribution: North and Mediterranean Seas.

NITSCHIA GRANULATA Grunow. Plate 1, fig. 10.

PERAGALLO, Diatom. Mar. France pl. 69, fig. 20.

Length, 0.048 millimeter; breadth, 0.01 millimeter. Striæ 6 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans, North America, Japan, China, Ceylon.

NITSCHIA (GOMPHONITZSCHIA) CHINENSIS sp. nov. Plate 3, fig. 1.

Valve club-shaped, increasing in width from base to apex, slightly curved; its surface marked by transverse lines, the most of which are curved in the middle or furcated. A longitudinal line runs through the length of the valve and has the appearance of the coarse lines of *Nitschia*. Length, 0.5 to 0.065 millimeter; breadth, 0.0057 to 0.011 millimeter. Transverse lines 5 in 0.01 millimeter.

SURIRELLA FLUMINENSIS Grunow. Plate 1, fig. 5.

A. SCHMIDT, Atlas Diatom. pl. 4, fig. 9; pl. 5, fig. 6.

Valve ovate. Length, 0.053 millimeter; breadth, 0.035 millimeter. Geographic distribution: North, Mediterranean, and Yellow Seas, Japan.

SURIRELLA VOIGTII sp. nov. Plate 1, figs. 1 to 3; pl. 2, fig. 1.

Valve elongated ovate, one end broad and rounded, the other end elongated, somewhat pointed and curved; outer rim a narrow band, within the rim broad ribs or costæ proceed toward the center, making a band about the middle of the valve and leaving a hyaline thin central area about one-tenth the valve's diameter. Each costa begins at the outer band with a broad enlargement, covered with thin striation, but is bordered for a short distance near its middle part of the valve with a row of beards on the side. Length, 0.4 to 0.102 millimeter; breadth, 0.023 to 0.047 millimeter. Striæ 15 to 18 in 0.01 millimeter. Named in honor of Mr. Manfred Voigt, Shanghai.

ILLUSTRATIONS

PLATE 1

FIGS. 1 to 3. *Surirella voigtii* sp. nov.
FIG. 4. *Biddulphia arcticum* (Brightwell) Cleve var. *formosa* Brightwell.
5. *Surirella fluminensis* Grunow.
6. *Navicula brasiliensis* Grunow.
7. *Actinoptychus annulatus* (Wallich) Grunow var. *minor* Grunow.
8. *Cocconeis grevillei* W. Smith var. *typica* Cleve.
9. *Synedra robusta* Ralfs var. *sinica* var. nov.
10. *Nitschia granulata* Grunow.
11. *Biddulphia grundleri* A. Schmidt.

PLATE 2

FIG. 1. *Surirella voigtii* sp. nov.
FIGS. 2 and 3. *Biddulphia grundleri* A. Schmidt.
FIG. 4. *Cocconeis pelta* A. Schmidt var. *japonica* var. nov.
5. *Biddulphia concava* Mann.
6. *Trachyneis aspera* Ehrenberg var. *chinensis* var. nov.
7. *Grammatophora angulosa* Ehrenberg var. *hamulifera* Kützing.
8. *Nitschia lancettula* O. Müller var. *chinensis* var. nov.
9. *Achnanthes brevipes* Agardh var. *japonica* var. nov.
10. *Amphora angusta* (Gregory) Cleve var. *chinensis* var. nov.
FIGS. 11 and 12. *Biddulphia obtusa* Grunow.
FIG. 13. *Achnanthes brevipes* Agardh var. *leudugeri* Tempere and Brun.
14. *Trachyneis aspera* Ehrenberg var. *pulchella* W. Smith.
15. *Frustulia interposita* Lewis var. *chinensis* var. nov.
16. *Frustulia lewisiana* Greville.

PLATE 3

FIG. 1. *Nitschia* (*Gomphonitschia*) *chinensis* sp. nov.
2. *Pleurosigma elongatum* W. Smith var. *sinica* var. nov.
3. *Gyrosigma distortum* W. Smith.
4. *Pleurosigma longum* Cleve var. *inflata* Peragallo.
5. *Gyrosigma fasciola* Ehrenberg var. *tenuirostris* Grunow.
6. *Gyrosigma grovei* Cleve.
7. *Gyrosigma scalproides* Rabenhorst var. *eximia* Thw.
8. *Gyrosigma spencerii* W. Smith var. *acutiuscula* Grunow (?).
9. *Pleurosigma angulatum* Quekett.

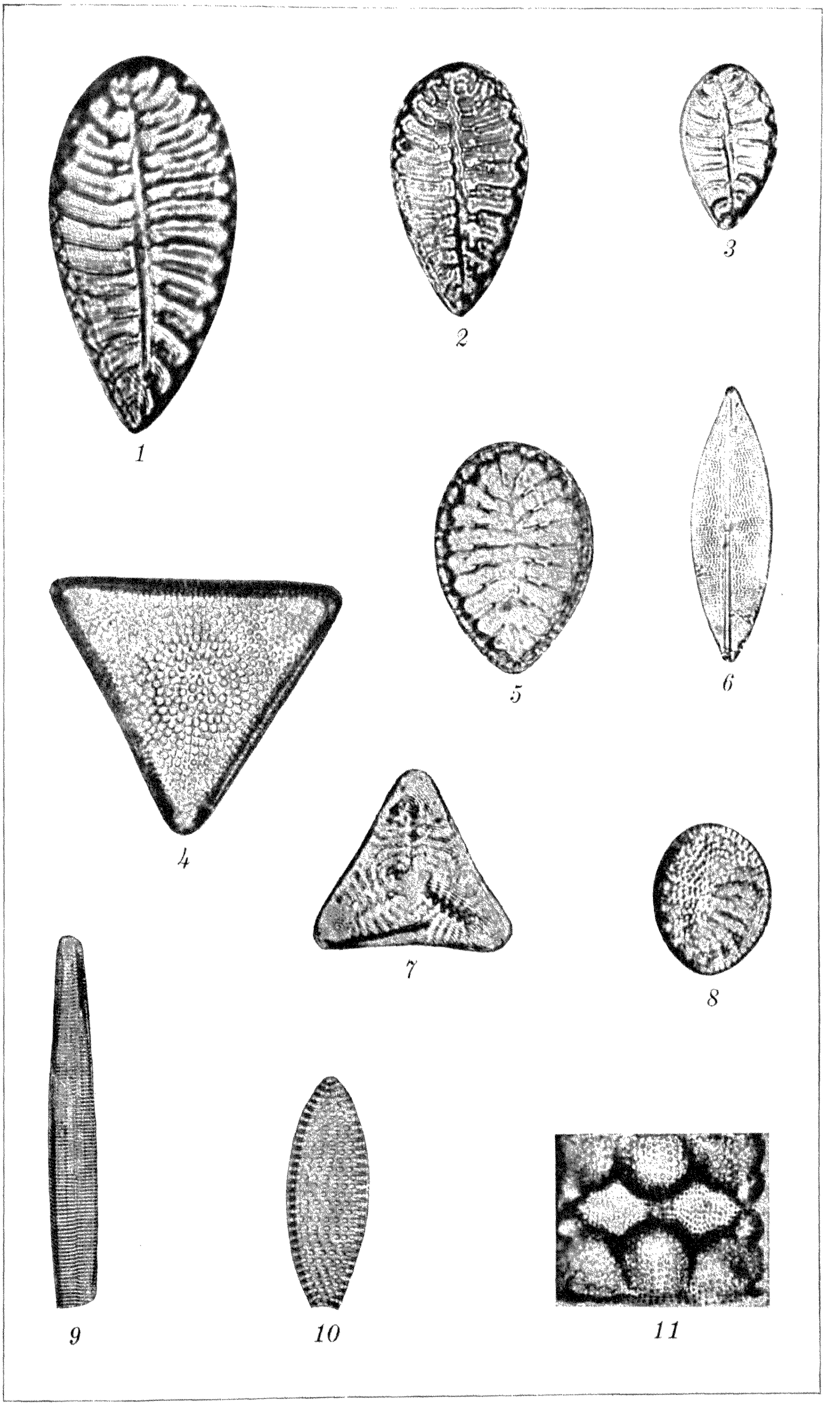

PLATE 1.

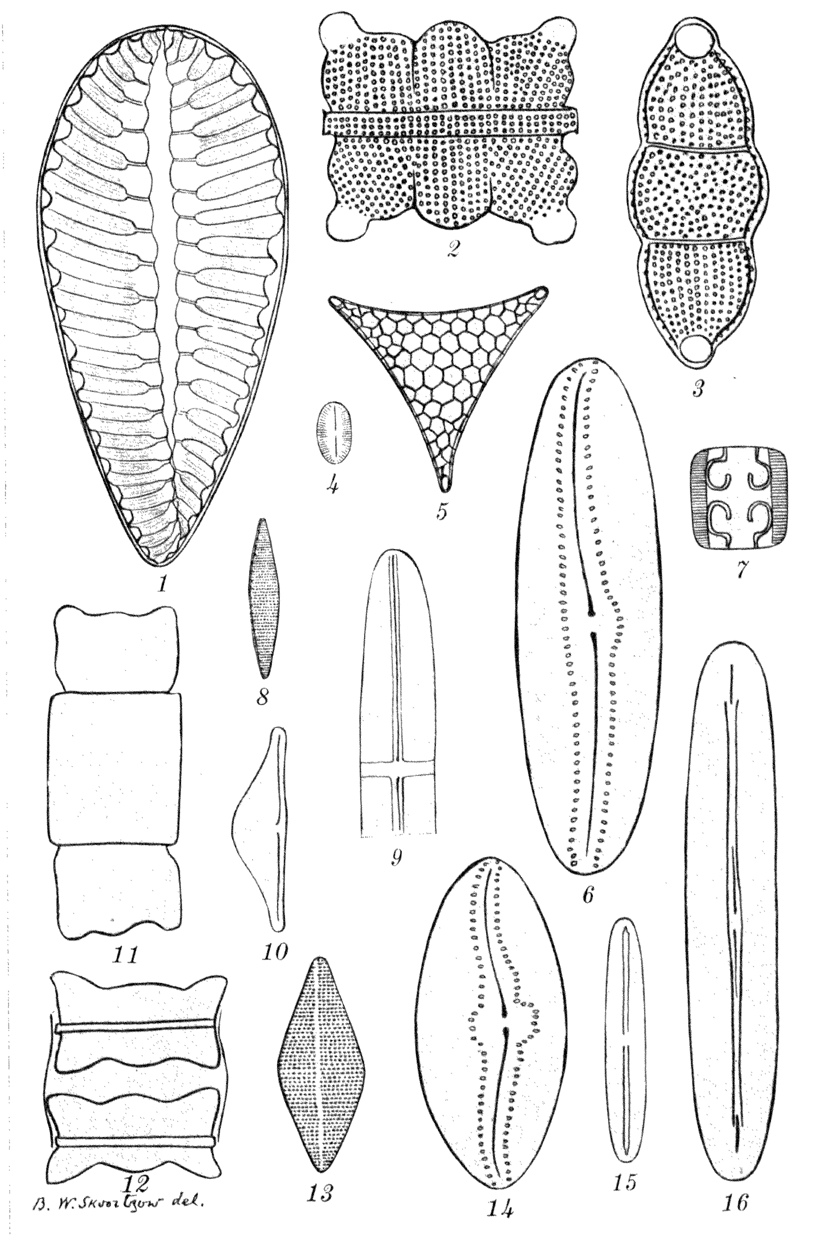

PLATE 2.

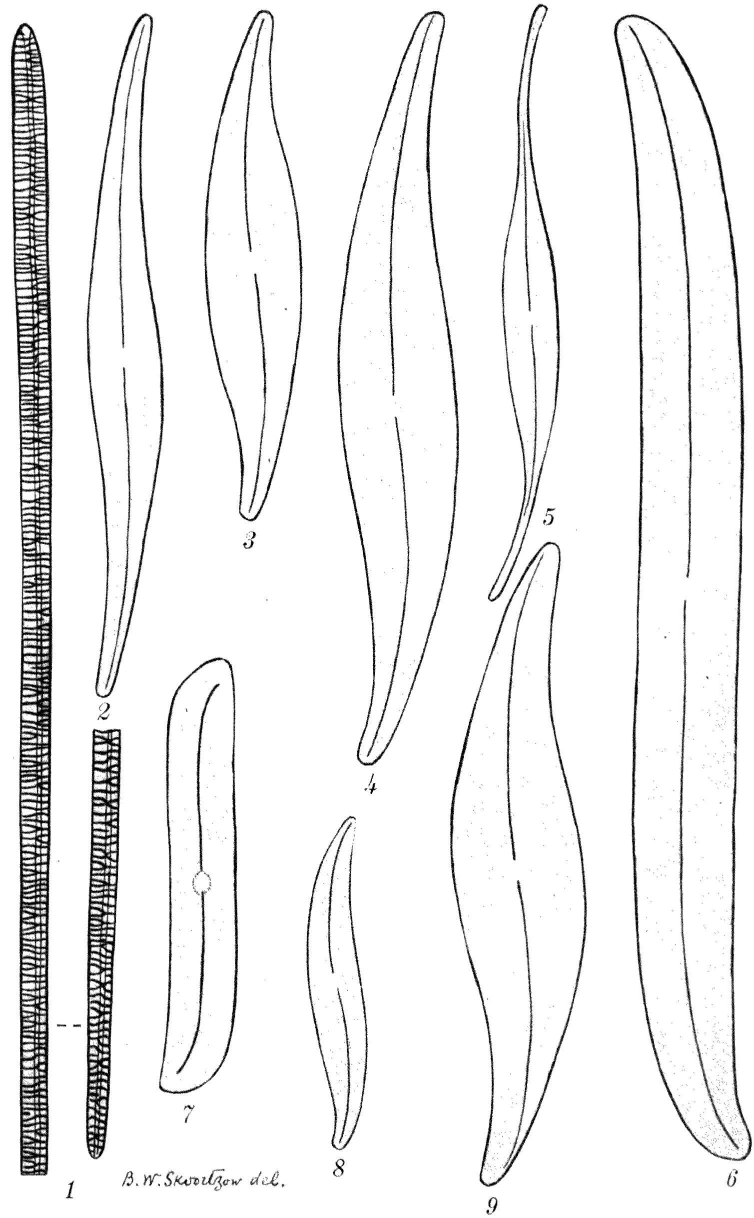

PLATE 3.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM THE PHILIPPINES (DIPTERA), XIII[1]

By Charles P. Alexander

Of Amherst, Massachusetts

THREE PLATES

The crane flies discussed at this time are all from Mount Apo, Mindanao, where they were collected by my former student, Mr. Charles F. Clagg. Keys are provided for the separation of the Philippine species of *Dolichopeza, Helius*, and *Pseudolimnophila*.

TIPULINÆ

SCAMBONEURA CLAGGI sp. nov. Plate 1, fig. 1; Plate 2, fig. 19.

General coloration orange, the præscutal stripes scarcely evident; antennæ (male) short; wings with Rs in alignment with the remaining elements of the cord, opposite Sc_2; male hypopygium with the outer dististyle a curved rod, the apex blackened and obliquely truncated; appendage of ninth sternite a depressed prow-shaped lobe, narrowed to the obtuse apex.

Male.—Length, about 12.5 to 13 millimeters; wing, 14.5 to 15.

Female.—Length, about 18 to 19 millimeters; wing, 15 to 16.

Frontal prolongation of head orange; palpi dark brown. Antennæ (male) relatively short, if bent backward not extending far beyond the root of the halteres; first scapal segment obscure yellow, the remainder of the organ black. Head orange, with a narrow capillary brown median line, together with less distinct brown spots on the orbits.

Mesonotal præscutum orange-yellow, with three more reddish-orange stripes that are little distinct against this background; remainder of mesonotum chiefly obscure orange or olivaceous orange, the scutal lobes a little darker than the median portion, scutellum with a more or less distinct brown median vitta. Pleura yellow. Halteres dark brown, the base of the stem very

[1] Contribution from the entomological laboratory, Massachusetts State College.

restrictedly pale. Legs with the coxæ and trochanters orange; remainder of legs black, the femoral bases restrictedly brightened. Wings (Plate 1, fig. 1) whitish hyaline, cell Sc and the stigma darker; veins black. Venation: Sc_1 present; Sc_2 ending opposite Rs, the latter in oblique alignment with the remaining elements of the cord; inner end of cell R_3 lying slightly proximad of that of cell R_5.

Abdominal tergites obscure yellow, ringed at midlength with broad violaceous annuli, the pale basal ring wider than the concolorous apex of the segment; subterminal segments and hypopygium passing into black; sternites more uniformly yellow. In the female, the apical dark ring of the sternite is more broadly metallic blue, the pale apex being obliterated or nearly so. Male hypopygium (Plate 2, fig. 19) with the lateral lobes of the tergite, *9t*, broadly obtuse, each at apex on lower face with a blackened spine, the remainder of lobe with smaller microscopic black spinules; no median projection. Outer dististyle, *od*, a conspicuous curved rod, somewhat as in *mindanaoensis*, the apex obliquely truncated and blackened. Inner dististyle, *id*, a broadly flattened blade, the terminal beak unusually small. Appendage of ninth sternite, *9s*, relatively slender, prowshaped, broadest just before midlength, gradually narrowed to the slender tip, the surface densely clothed with microscopic setulæ. Gonapophyses, *g*, appearing as yellow blades, bifid at tip, the lateral portions produced into a slender black spine; face of blade with a second, much smaller spine.

MINDANAO, Davao district, Mount Apo (*C. F. Clagg*); holotype, male, Seliban River, altitude 7,000 feet, September 3, 1930; allotype, female, Mainit River, altitude 6,500 feet, September 10, 1930; paratopotype, male, with holotype; paratypes, 2 males, 1 female, with allotype, altitude 6,000 feet, September 9, 1930; 1 male, Galog River trail, altitude 5,000 to 6,000 feet, September 12, 1930.

This very distinct *Scamboneura* is named in honor of the collector of this rich series of Tipulidæ from Mindanao, Mr. Charles F. Clagg. By my latest key to the Philippine species of *Scamboneura*[2] the present species runs to couplet 3 which includes *S. primæva* Alexander and *S. primogenia* Alexander, both of Luzon. The fly is more closely allied to the more recently defined *S. mindanaoensis* Alexander (Mindanao), differing conspicuously in the hypopygial structure. These two species are

[2] Philip. Journ. Sci. 45 (1931) 266.

very distinct from all other described species of the genus in the peculiar structure of the outer dististyle of the male hypopygium.

SCAMBONEURA CITRIDORSUM sp. nov. Plate 1, fig. 2; Plate 2, fig. 20.

General coloration orange, the præscutal stripes almost concolorous; antennæ (male) long, the flagellum black; vertex orange, with a narrow brown line; wings with the elements of the anterior cord in subtransverse alignment, the inner end of cell R_3 lying slightly more distad than cell R_5; male hypopygium with the appendage of the ninth sternite a depressed spatula, the apex not at all emarginate or bilobed.

Male.—Length, about 12.5 millimeters; wing, 13.5.

Frontal prolongation of head orange, the nasus darker, tufted with dark setæ; palpi obscure yellow, the outer segments darker. Antennæ (male) elongate, if bent backward extending about to midlength of the second abdominal segment; scapal segments brownish yellow, flagellum black; flagellar segments elongate-cylindrical, the basal enlargement small. Head orange, with a narrow brown line that extends cephalad almost to the summit of vertex.

Thoracic notum almost clear orange, the præscutal stripes ill-defined to nearly obsolete; scutellum more infuscated. Pleura yellowish orange, immaculate. Halteres light brown, the knobs dark brown. Legs with the coxæ and trochanters yellow; femora obscure yellow, passing into brownish black at tips; tibiæ and tarsi black. Wings (Plate 1, fig. 2) subhyaline, cell Sc and the stigma darker brown; a narrow to scarcely evident dusky marginal clouding from wing apex to opposite cell Cu; veins and macrotrichia black. Venation: Elements of anterior cord in subtransverse alignment, the inner end of cell R_3 lying slightly more distad than cell R_5; m-cu transverse to the wing, in alignment with the remaining elements of the cord.

Abdominal tergites orange, marked medially and less evidently on margins with brownish black, the amount of the former increasing conspicuously on the outer segments to form a complete but irregularly outlined median stripe; subterminal segments and hypopygium uniformly darkened. Male hypopygium (Plate 2, fig. 20) with the median tooth of the tergite, *9t*, small and inconspicuous. Inner dististyle, *id*, long and narrow, gradually narrowed into a long apical darkened point, the extreme tip obtusely rounded. Appendage of ninth sternite, *9s*, a depressed spatula, widened outwardly, the apex subtruncate, not

emarginate or bilobed; entire surface densely set with setæ and setulæ, the latter arranged in definite groups of three or four; marginal setæ longer, especially on the lateral and subapical portions.

MINDANAO, Davao district, Mount Apo, Seliban River, altitude 7,000 feet, September 3, 1930 (*C. F. Clagg*); holotype, male.

By my key to the Philippine species of *Scamboneura*[3] the present species runs to *S. subtransversa* Alexander, with which it agrees in the nature of the anterior cord of the wings, differing conspicuously therefrom in the coloration and in the structure of the male hypopygium.

SCAMBONEURA SUBDOTATA sp. nov. Plate 2, fig. 21.

General coloration yellow, the præscutum with three metallic green stripes that are narrowly bordered by black; antennæ (male) elongate, the basal flagellar segments bicolorous; head with a conspicuous occipital area and a median black line to summit of vertex; wings with anterior cord bowed; male hypopygium with the ninth tergite transverse, the lateral shoulders rounded; appendage of ninth sternite produced into conspicuous lateral horns.

Male.—Length, about 12 millimeters; wing, 11.5; antenna, about 6.

Female.—Length, about 18 millimeters; wing, 14.

Frontal prolongation of head yellow, nasus black; palpi yellow, the elongate terminal segment passing into brown. Antennæ (male) elongate, as shown by the measurements; scape yellow; flagellum black, the apex of each of the basal three segments yellow, most extensively so on the first segment, the amount decreasing outwardly. Head orange, the occipital area extensive, gray, margined with black, the latter coloration continued cephalad onto the summit of the vertical tubercle; posterior orbits narrowly grayish.

Pronotum brownish gray laterally, brownish medially in front, yellow medially behind. Mesonotal præscutum yellow, with three shiny dark green stripes that are narrowly bordered by black; a dusky lateral extension from the cephalic portion of the lateral stripes; humeral region and lateral margin of sclerite before the suture brownish gray; suture darkened medially; scutum obscure yellow, the lobes chiefly covered by two confluent dark green areas, the mesal edge of which is blackened; scutellum and postnotum brownish testaceous, vaguely darker medial-

[3] Loc. cit.

ly. Pleura obscure yellow, the dark pattern of *dotata* but little evident, appearing as very pale brown areas on the propleura, anepisternum, and ventral sternopleurite. Halteres black, the extreme base of stem brightened. Legs with the coxæ yellow, the fore coxæ darkened on cephalic face; trochanters yellow; femora obscure yellow, darkened beyond base; tibiæ and tarsi passing from brown to dark brown. Wings proportionately wider than in *dotata;* venation almost the same, with m-cu more erect and vein 2d A a little longer.

Abdominal tergites obscure yellow, each with a median black area on the posterior ring; hypopygium chiefly yellow and brownish yellow. Male hypopygium (Plate 2, fig. 21) with the ninth tergite, 9*t*, transverse, the lateral shoulders evenly rounded, the median region with blackened spicules, as shown. Dististyles about as illustrated, the inner, *id,* relatively narrow, blackened. Appendage of ninth sternite, 9*s*, produced laterad into conspicuous lobes that are tufted with setæ, the apex beyond these lobes obtusely rounded and margined with pale, toothlike setæ.

MINDANAO, Davao district, Mount Apo, Galog River, altitude 6,000 feet, September 16, 1930 (*C. F. Clagg*); holotype, male.

By my key to the Philippine species of *Scamboneura*[4] the present fly runs to *S. dotata* Osten Sacken, which appears to be its nearest ally. *Scamboneura subdotata* is told by the longer antennæ and the very different details of the male hypopygium, notably of the tergite and appendage of the ninth sternite.

SCAMBONEURA OPACINOTUM sp. nov. Plate 2, fig. 22.

General coloration yellowish and gray, the mesonotal præscutum with three brown stripes that are more or less confluent and covered by a gray pruinosity; basal flagellar segments black, with narrow yellow apices; pleura whitish yellow, unmarked; wings whitish subhyaline, the stigma darker; anterior cord strongly bowed; male hypopygium having the tergite with abundant microscopic blackened points; apical beak of inner dististyle stout; appendage of ninth sternite a depressed lobe that is folded into a half-cylinder by the upcurving of the margins.

Male.—Length, about 12 to 13 millimeters; wing, 11.5 to 12.

Female.—Length, 15 to 16 millimeters; wing, 12 to 12.5.

Frontal prolongation of head obscure yellow, the nasus darkened; palpi obscure yellow, the outer segments darkened. Antennæ (male) relatively elongate, if bent backward extending

[4] Loc. cit.

about opposite or slightly beyond midlength of the second abdominal segment; first scapal segment brown, the second clear light yellow; flagellar segments black, the apices of the basal two restrictedly pale yellow. Posterior portion of vertex and the occiput gray pruinose, the remainder of vertex and front yellow, the occipital portions with a light silvery pruinosity; central portion of vertex with a narrow velvety-black median vitta that almost attains the summit of the tubercle.

Mesonotal præscutum with the ground color obscure yellow, with three brown stripes that may become entirely confluent and so cover the disk; entire surface heavily pruinose; scutal lobes gray, the restricted median region obscure yellow; scutellum brownish yellow; postnotal mediotergite gray medially, obscure yellow laterally. Pleura obscure yellow, whitish pruinose, not or scarcely variegated with darker. Halteres obscure yellow, the stem more obscure, the knobs brownish black. Legs with the coxæ pale, whitish pruinose; trochanters yellow; femora obscure yellow, with dark setæ that somewhat obscure the ground color, especially distally; remainder of legs passing through yellowish brown to black. Wings whitish subhyaline, cell Sc more yellowish; stigma pale brown; veins black, with long conspicuous macrotrichia. Venation: Anterior cord very deeply bowed, as usual in the more-specialized species of the genus.

Abdominal segments yellow, the tergites trivittate with dark brown, the proximal segments narrowly ringed with yellow; hypopygium brownish black. Male hypopygium (Plate 2, fig. 22) with the tergite, *9t*, provided with abundant blackened spinous points, the larger ones on the ventral face of the lobes; median tonguelike point small. Inner dististyle, *id*, with the apical point stouter than in *banahaoensis*. Appendage of the ninth sternite, *9s*, of a form difficult of description and illustration, being a depressed structure having the margins upcurved to form a half-cylinder, the lateral ears projecting.

MINDANAO, Davao district, Mount Apo (*C. F. Clagg*); holotype, male; allotype, female, Mainit River, altitude 6,500 feet, September 14, 1930; paratopotypes, 5 males and females, September 10 to 14, 1930; paratypes, 3 males, Galog River, altitude 6,000 feet, September 7 and 8, 1930; 1 male, Seliban River, altitude 6,500 feet, September 11, 1930; Bakraeyon, altitude 8,000 feet, September 16, 1930.

By my key to the Philippine species of *Scamboneura*[5] the present species runs to *S. banahaoensis* Alexander (Luzon) which differs in the details of the hypopygium, especially the number and arrangement of the spinulæ on the tergite, the stouter beak of the inner dististyle, and the conformation of the appendage of the ninth sternite.

Genus DOLICHOPEZA Curtis

The genus *Dolichopeza* is very greatly developed in the Philippine fauna, the majority of the species falling within the limits of the subgenus *Nesopeza* Alexander, as restricted by the present writer. A single species of *Mitopeza* Edwards has been described from Luzon. The three species referred provisionally to *Dolichopeza*, s. s., deserve special comment. In several respects these species are closer to *Tipula* than to *Dolichopeza*, and almost certainly form a close connection between these two groups. The following attempt to key the Philippine species of the genus is based especially on the structure of the male hypopygium.

Key to the Philippine species of Dolichopeza Curtis.

1. Wings with cell 1st M_2 closed. (*Mitopeza* Edwards.) (Luzon.)
   D. (*M.*) *rizalensis* Alexander.

   Wings with cell 1st M_2 open by atrophy of the basal section of M_3........ 2.
2. Rs short to transverse, not exceeding two-thirds the length of the long m-cu; tibiæ and tarsi entirely black. (*Dolichopeza* Curtis, s. s.; *malagasya* group.) .... 3.

   Rs elongate, longitudinal in position, two or more times the length of m-cu; tarsi, and usually the tibiæ also, more or less whitened. (*Nesopeza* Alexander.) .... 5.
3. General coloration of head and thorax orange, the thoracic pleura immaculate; wings conspicuously patterned with darker in the outer radial field, especially a cloud beyond the anterior cord that sends seams outward along the radial veins; antennal flagellum black. (Mindanao.) .... *D.* (*D.*) *ata* sp. nov.

   General coloration of head and thorax more yellowish testaceous, the pleura with small black spots on the pteropleurite; wings only inconspicuously patterned; antennæ with the flagellum brown or weakly bicolorous .... 4.
4. Antennæ (male) relatively elongate, if bent backward extending to beyond the base of abdomen; knobs of halteres blackened. (Luzon.)
   D. (*D.*) *isolata* Alexander.

[5] Loc. cit.

Antennæ (male) short, if bent backward extending to about mid-distance between the roots of the wings and the halteres; knobs of halteres with the outer half abruptly yellow. (Mindanao.)
D. (*D.*) *bilan* sp. nov.

5. Rs elongate, angulated and long-spurred at origin, exceeding vein R_{2+3} in length; wings with a heavy dark brown costal pattern or conspicuously spotted with dark .... 6.
Rs relatively short, not angulated or spurred at origin and not exceeding vein R_{2+3} in length; wings unmarked, except for the stigmal area .... 13.
6. Forks of medial field of wing shallow; that is, cell M_1 less than twice as long as its petiole. (*costalis* group.) .... 7.
Forks of medial field of wing deep; that is, cell M_1 about three or more times as long as its petiole. (*gracilis* group.) .... 8.
7. Wings with a dark costal pattern only. (Luzon.)
D. (*N.*) *oberon* Alexander.
Wings with the costa more or less darkened, the disk and posterior wing margin with conspicuous yellowish brown areas that are narrowly margined with darker. (Mindanao.)
D. (*N.*) *multiguttula* sp. nov.
8. Wings dusky, the costa dark brown, cell R_2 not variegated by pale spots; legs with femora and tibiæ darkened, the latter with a narrow white ring before the black tips. (Mindanao.)
D. (*N.*) *nigrofemorata* sp. nov.
Wings with the dark costal border variegated by pale marginal spots in the outer ends of cells R_2 and R_3; legs with the femora and tibiæ pale, yellowish or yellowish white, the tips narrowly darkened...... 9.
9. Thoracic pleura entirely pale or with a restricted dark pattern; all coxæ pale .... 10.
Thoracic pleura pale, heavily variegated by dark brown, this pattern including the fore coxæ .... 11.
10. Thoracic pleura uniformly pale; male hypopygium with the region of the basistyle produced into a powerful fascicle of setæ and spines to resemble a single powerful spine. (Mindanao.)
D. (*N.*) *spinisternata* Alexander.
Thoracic pleura pale, with an interrupted dorsal brown stripe; male hypopygium with the armature of the basistyle and sternite consisting only of long scattered setæ. (Mindanao.)
D. (*N.*) *setisternata* sp. nov.
11. Male hypopygium with the region of the basistyle produced into a slender fingerlike lobe that is tipped with spinous setæ. (Mindanao.)
D. (*N.*) *productula* sp. nov.
Male hypopygium without such production of the region of the basistyle .... 12.
12. Thoracic pleura continuously darkened; except for the pleurotergite and dorsal membrane; male hypopygium with the sternal region unarmed except for a crown of about six flattened spinous setæ on either side of a membranous median notch. (Mindanao.)
D. (*N.*) *parvella* sp. nov.

Thoracic pleura dark, interrupted by pale areas, especially on the dorsal sternopleurite; male hypopygium with conspicuous lateral and median spines on the sternal region. (Mindanao.)
D. (*N.*) *paucispinosa* Alexander.

13. Wings cuneiformly narrowed at base; cell 2d A of wings very long and narrow, reduced to a linear strip; tarsi white, on some of the legs with central portion of basitarsi extensively blackened. (*cuneata* group.) .... 14.
Wings not so cuneiformly narrowed, cell 2d A of wings of normal width; tarsi white, the central portion of basitarsi not blackened. (*tarsalis* group.) (Luzon.) .... *D.* (*N.*) *haightensis* Alexander.

14. Male hypopygium with the ninth tergite very long and narrow, conspicuously arched dorsad. (*cinctitarsis* subgroup.) .... 15.
Male hypopygium with the ninth tergite small and not greatly arched dorsad. (*cuneata* subgroup.) .... 17.

15. Male hypopygium with the ninth tergite having the lobes broad, each obliquely truncated to weakly notched at tips, the mesal edge of each beyond midlength with a slender appendage directed cephalad and ventrad. (Luzon.) .... *D.* (*N.*) *cinctitarsis* Alexander.
Male hypopygium with the lobes of the ninth tergite long and narrow .... 16.

16. Male hypopygium with the apex of each lobe of the ninth tergite simple or nearly so. (Luzon.) .... *D.* (*N.*) *annulitarsis* Alexander.
Male hypopygium with the apex of each lobe of the ninth tergite profoundly split into two slender arms. (Mindanao.)
D. (*N.*) *quadrifila* sp. nov.

17. Male hypopygium with the ninth sternite conspicuously blackened; lateral lobes of tergite broad, entire or nearly so. (Luzon.)
D. (*N.*) *melanosterna* Alexander.
Male hypopygium with the ninth sternite pale; lateral lobes of tergite divided into lateral and sublateral portions by a notch.......... 18.

18. Male hypopygium with the sublateral tooth of the tergite acute, separated from the extreme lateral lobe by a narrow V-shaped notch. (Luzon.) .... *D.* (*N.*) *angustaxillaris* Alexander.
Male hypopygium with the sublateral tooth of the tergite relatively small, separated from the extreme lateral lobe by a very broad and shallow notch. (Mindanao.) .... *D.* (*N.*) *bagobo* sp. nov.

DOLICHOPEZA (DOLICHOPEZA) ATA sp. nov. Plate 1, fig. 3; Plate 2, fig. 23.

Belongs to the *malagasya* group; antennæ (male) relatively elongate, the flagellum black; general coloration of head and thoracic notum orange, the præscutum with the interspaces a little darkened; thoracic pleura yellow, immaculate; knobs of halteres blackened; wings cream-colored, conspicuously variegated with brown; male hypopygium with the tergite bearing a highly compressed spatulate blade that is densely clothed with long erect setæ; inner dististyle bearing a long, tail-like extension.

Male.—Length, about 10 to 11 millimeters; wing, 13 to 13.5. Frontal prolongation of head fulvous; palpi black. Antennæ with the scapal segments yellow, the flagellum black; flagellar segments elongate-cylindrical, the basal enlargements only slightly developed, the verticils shorter than the segments. Head orange.

Mesonotal præscutum orange, the interspaces vaguely to insensibly more brownish orange; scutal lobes obscure yellow, variegated with large brown areas; scutellum brownish testaceous; postnotum yellow. Pleura yellow. Halteres with the stem brown, the knobs blackened. Legs with the coxæ and trochanters yellow; femora obscure yellow at base, passing through brown to black; tibiæ and tarsi black. Wings (Plate 1, fig. 3) cream-colored, conspicuously variegated by dark brown; stigma dark brown; cell Sc dark brown; cell C more or less infuscated, especially on distal half; extensive dusky clouds at anterior cord and as seams along the veins distad of the same; Cu and m-cu broadly and conspicuously seamed with brown; vein 2d A narrowly margined with dusky; veins brown, except in obliterative areas. Caudal half of stigma with several conspicuous macrotrichia. Venation: Forks of media very deep; base of R_2 and R_1 forming an acute angle at their point of union; R_{1+2} represented by a distinct spur that is more than one-half the length of R_2 alone.

Abdominal tergites obscure yellow, margined basolaterally and caudally with black, on segments five to nine more extensively and uniformly blackened; sternites chiefly yellow, narrowly margined caudally with brownish black; eighth sternite uniformly blackened. Male hypopygium (Plate 2, fig. 23) with the median region of the tergite, 9*t*, produced caudad into a very compressed spatulate blade, the two faces of which bear unusually long and abundant erect setæ. Outer dististyle a flattened to subcylindrical fleshy lobe. Inner dististyle, *id*, as illustrated, the posterior end prolonged into a long straight spine, the distal third blackened and glabrous.

MINDANAO, Davao district, Mount Apo, Kidapawan trail from Lake Lino, altitude 7,000 to 8,000 feet, September 20, 1930 (*C. F. Clagg*); holotype, male; paratype, male.

The specific name is that of a native tribe of the vicinity of Mount Apo. As indicated before, the species of the *malagasya* group are referred to *Dolichopeza* with much hesitation. When their limits are better understood, it seems probable that

this particular group of flies will be transferred to *Tipula,* but there can be little question that flies of this type were very similar to the ancestors of *Dolichopeza.*

DOLICHOPEZA (DOLICHOPEZA) BILAN sp. nov.

Belongs to the *malagasya* group; general coloration obscure yellow; antennæ (male) relatively short, if bent backward extending about to mid-distance between the bases of the wings and halteres; mesonotal præscutum with three obscure yellow stripes; pleura with small black spots; halteres dark, the apices of the knobs conspicuously light yellow; wings without a clearly defined dark pattern, as is the case in *D. atá.*

Male.—Length, about 10 millimeters; wing, 11.5.

Female.—Length, about 11 millimeters; wing, 11.

Frontal prolongation of head light brown to brownish yellow; palpi black. Antennæ of male of moderate length only, if bent backward extending to about mid-distance between the wings and halteres; scapal segments obscure yellow; flagellum brownish black. Head with the anterior vertex obscure yellow, the posterior vertex more infuscated, paler medially.

Mesonotal præscutum with three obscure yellow stripes, the interspaces and humeral region dark brown; median stripe vaguely divided by a faint line; scutal lobes conspicuously patterned with dark brown; scutellum and postnotal mediotergite dark, the latter slightly pruinose. Pleura obscure yellow, with small black areas on the ventral dorsopleural membrane, and with two isolated areas on the cephalic margin of the pteropleurite. Halteres infuscated, the base of stem and apex of each knob light yellow. Legs with the coxæ and trochanters yellowish testaceous; femora passing through brown to black; tibiæ and tarsi black. Wings with a dusky tinge, variegated by restricted seams along certain of the veins; cream-colored obliterative areas before and beyond the stigma, and across the basal section of M_{1+2} ; veins dark, pale in the obliterative areas. A few macrotrichia in caudal half of the stigma. Venation: Forks of medial field deep.

Abdominal tergites bicolorous, the incisures broadly darkened, including the broad caudal margin and more narrow basal portion of the segment; sternites more uniformly pale, the darkened areas narrower and restricted to the caudal margins of the segments. Male hypopygium almost as in *D. atá,* differing chiefly in details of structure of the inner dististyle, there being a

conspicuous tubercle at base of the posterior spine, the latter stouter and destitute of setæ for a longer distance back from apex.

MINDANAO, Davao district, Mount Apo (*C. F. Clagg*); holotype, Mainit River, altitude 6,000 feet, September 4, 1930; allotype, female, Galog River, altitude 6,000 feet, September 11, 1930, at camp fire.

The specific name is that of a native aboriginal tribe.

DOLICHOPEZA (NESOPEZA) MULTIGUTTULA sp. nov. Plate 1, fig. 4.

Belongs to the *costalis* group; general coloration of thorax pale yellow, the præscutum with three pale brown stripes, the pleura variegated with brown; legs chiefly pale, the tips of the femora and tibiæ blackened; wings subhyaline, with a heavy yellowish brown pattern, the areas bordered by darker brown; caudal margin of wing with dark areas at ends of all the veins; forks of medial field shallow.

Male.—Length, about 8 millimeters; wing, 9.

Female.—Length, about 10 millimeters; wing, 10 to 10.5.

Frontal prolongation of head very short, dark brown; palpi brownish black. Antennæ (male) relatively long and slender; second scapal segment and basal half of first flagellar segment yellow, the basal segment of scape and remainder of flagellum brown; flagellar segments elongate-cylindrical, clothed with an abundant erect pubescence and with a single verticil before apex, together with a subbasal one on the more proximal segments. Head brownish gray; anterior vertex relatively narrow, less than twice the diameter of the first scapal segment.

Mesonotal præscutum pale yellow, with three poorly defined pale brown stripes, the median one further divided by a capillary shiny line; scutal lobes with two yellowish brown areas that almost cover the lobes; scutellum and central portion of the postnotal mediotergite dark brown, the lateral margins of the latter yellow. Pleura yellow, conspicuously variegated with brown, the latter including the anepisternum, ventral sternopleurite, and meron; the dorsocaudal portion of the pleurotergite is pale brown but still darker than the ground. Halteres pale yellow, the knobs infuscated. Legs with the fore coxæ infuscated, the remaining coxæ and all trochanters yellow; femora obscure yellow, the tips narrowly blackened; tibiæ white, clearest at extreme base and again on distal third, the tip very narrowly but conspicuously blackened; tarsi snowy white. Wings (Plate 1, fig. 4) subhyaline, with a heavy pale yellowish brown pattern that is

narrowly margined with paler; costal region pale or infuscated, in the latter case variegated by pale areas; the chief darkened areas are caudal extensions of the costal field, as in the *costalis* group, but in addition, there are conspicuous marginal areas at ends of all the veins, with a larger area in outer end of cell 1st A, remote from the veins; other dark areas occur at and beyond the arculus, at m-cu, and near outer ends of the radial cells; veins brown, the anal veins paler. Macrotrichia of veins relatively long and conspicuous. Venation: Rs angulated and conspicuously spurred at origin; free tip of Sc_2 pale but preserved; R_{1+2} entirely atrophied, the juncture of R_2 with R_1 usually feebly angulated; R_3 long, upcurved at margin; forks of medial field short, cell M_1 subequal to its petiole; cell 2d A wide.

Abdominal tergites dark brown, margined laterally with yellow; in the female, the segments more variegated.

MINDANAO, Davao district, Mount Apo (*C. F. Clagg*); holotype, male, Mainit River, altitude 7,000 feet, September 15, 1930; allotype, female, Lino Lake to summit, 8,000 to 9,300 feet, September 18, 1930; paratype, female, Seliban River, 7,000 feet, September 3, 1930.

The wing pattern serves to separate this conspicuous fly from related regional forms.

DOLICHOPEZA (NESOPEZA) NIGROFEMORATA sp. nov. Plate 2, fig. 24.

Belongs to the *gracilis* group; general coloration obscure yellow, the mesonotal præscutum with three extensive brown stripes; femora and tibiæ dark, obscure brownish yellow to blackish, the tibiæ narrowly whitened before the extreme blackened tips; tarsi snowy white; wings dusky, with the usual dark costal pattern, cell R_2 not variegated by pale spots; male hypopygium with the region of the basistyle produced into broad shoulders that bear several powerful setæ which are directed mesad.

Male.—Length, about 10 millimeters; wing, 10 to 10.2.

Frontal prolongation of head brownish black; palpi black. Antennæ with the scape and first flagellar segment obscure yellow, the remainder of flagellum passing into black; flagellar segments cylindrical, the segments beyond the first with erect pubescence but without further differentiated verticils; terminal segment small, less than one-fifth the penultimate. Head brown, sparsely pruinose, more conspicuously so on the posterior orbits.

Mesonotal præscutum obscure yellow, with three extensive brown stripes, the median stripe expanded in front; in cases, the median stripe much paler, being best represented by a

capillary dark brown median vitta; scutal lobes obscure yellow, variegated on margins by brown; scutellum brown, the parascutella paler; postnotal mediotergite obscure testaceous yellow, darker medially. Pleura obscure brownish yellow, the pteropleurite, meron, and dorsopleural membrane clearer yellow. Halteres with the stem obscure yellow, the knobs infuscated. Legs with the coxæ and trochanters yellow; femora obscure brownish yellow to black, in the former case, the tips blackened; tibiæ dark testaceous brown, before the narrowly blackened tips brightening to white; tarsi snowy white.

Wings with a dusky suffusion, the costal border darker brown, as in the group; posterior extensions of this border across the postarcular cells, origin of Rs and along cord; cell R_2 almost uniformly dusky, not variegated with pale spots, as is usual in the group; veins dark brown. Venation: R_3 of moderate length only, about one-fifth longer than R_{2+3}; forks of medial field deep, that of cell M_1 exceeding three times the petiole.

Abdomen with the tergites black, the segments margined laterally at base and marked less distinctly medially with obscure yellow. Male hypopygium (Plate 2, fig. 24) with the median region of tergite, *9t*, slightly produced. Outer dististyle dusky, with long conspicuous setæ. Region of sternite, *9s*, and basistyle with the latter produced mesad and caudad into broad shoulders that bear from ten to twelve powerful setæ which are directed toward one another across the midline; sternal region with a shallow U-shaped notch, on either side of which is a low obtuse lobe set with spinous setæ, the more mesal ones smaller, the more lateral setæ long and conspicuous, very dense.

MINDANAO, Davao district, Mount Apo (*C. F. Clagg*); holotype, male, Lino Lake, altitude 8,000 feet, September 19, 1930; paratypes, 2 males, 1 teneral, Kidapawan trail from Lino Lake, 7,000 to 8,000 feet, September 20, 1930.

The diagnostic characters of the present species are well shown by the arrangement in the key.

DOLICHOPEZA (NESOPEZA) PRODUCTULA sp. nov. Plate 1, fig. 5; Plate 2, fig. 25.

Belongs to the *gracilis* group; general coloration buffy, the mesonotal præscutum with four brown stripes, the intermediate pair more or less confluent in front; pleura pale, variegated with dark brown, this color including the fore coxæ, ventral sternopleurite, and meron; legs pale, the tips of femora and tibiæ narrowly blackened; male hypopygium with the region of the

basistyle produced into cylindrical lobes that are tipped with spinous setæ.

Male.—Length, about 7 to 7.5 millimeters; wing, 7.5 to 8.5.

Female.—Length, about 8.5 to 9.5 millimeters; wing, 8.5 to 9.

Frontal prolongation of head short, dark brown; palpi black. Antennæ with the basal segment dusky, the second segment of scape and first segment of flagellum more yellowish; outer segments of flagellum passing into brown; flagellar segments elongate-cylindrical, provided with delicate erect setulæ and a single verticil on outer face near end of segment, this verticil not exceeding one-third the length of the segment. Head brown.

Mesonotal præscutum buffy, with four brown stripes, the intermediate pair confluent in front; scutal lobes marked on cephalic and mesal margins with a continuous brown line; scutellum brownish yellow; postnotal mediotergite a little darker. Pleura whitish, variegated with dark brown, including dorsal areas on the anepisternum and dorsal pleurotergite, and a ventral stripe including the fore coxæ, ventral sternopleurite, and meron. Halteres pale yellow, the knobs dark brown. Legs with the fore coxæ dark brown, the remaining coxæ and all trochanters yellow; femora obscure yellow, the tips brownish black; tibiæ white, the tips very narrowly darkened; tarsi white. Wings (Plate 1, fig. 5) with a pattern that is almost identical with that of *gracilis* and allies, including a dark costa that sends spurs caudad across the origin of Rs and along the anterior cord; pale areas in outer ends of cells R_2 and R_3; posterior cord and a marginal seam in the cubital and posterior medial fields restrictedly darkened; prearcular region dark. Venation: Forks of medial field deep, as in the *gracilis* group.

Abdominal tergites brownish black, variegated laterally and medially just before caudal margins of segments two to four with pale areas; subterminal segments more extensively darkened, the pale areas correspondingly restricted; sternites more extensively bicolorous, the posterior rings chiefly yellow, the incisures and basal rings infuscated. Male hypopygium (Plate 2, fig. 25) with the lateral arms of the tergite, *9t*, conspicuously produced, directed caudad and slightly mesad, the tips very obtuse, the arms with from 15 to 20 punctures; median area of tergite raised into a low lobe. Outer dististyle a short, flattened to cylindrical lobe, provided with many setæ. Inner dististyle, *id*, about as illustrated. Basistyle produced caudad into cylindrical arms

that bear several powerful spinous setæ at and near their tips; median region of sternite, 9*s*, with a group of about three similar setæ on either side, as illustrated.

MINDANAO, Davao district, Mount Apo (*C. F. Clagg*); holotype, male; allotype, female, Mainit River, altitude 6,500 feet, September 10, 1930; paratypes, 1 male, type locality, altitude 6,000 feet, September 16 to 24, 1930; 1 male, 1 female, Tio Ridge, altitude 6,500 feet, September 15, 1930; 2 males, 2 females, Seliban River, altitude 6,500 feet, September 11, 1930; 1 male, 1 female, Bakraeyon, altitude 8,000 feet, September 16, 1930.

DOLICHOPEZA (NESOPEZA) PARVELLA sp. nov. Plate 2, fig. 26.

Belongs to the *gracilis* group; size small (wing, male, less than 7.5 millimeters); thoracic pleura chiefly dark brown, variegated with pale on the dorsal membrane and on pteropleurite, the anepisternum and sternopleurite continuously darkened; wings with a dark costal pattern only; male hypopygium with the sternal region produced into a low tubercle on either side of the membranous median area, these lobes crowned with about six flattened spinous setæ.

Male.—Length, about 7 millimeters; wing, 7.2.

Frontal prolongation of head brownish black; palpi dark brown. Antennæ (male) elongate, if bent backward extending to the second abdominal segment; basal segment dark brown, the remainder pale brownish testaceous; flagellar segments elongate-cylindrical, the verticils inconspicuous. Head brownish black; anterior vertex narrow; eyes large.

Mesonotal præscutum with the ground color brownish black, with three ill-defined reddish brown stripes, the median one becoming narrowed and subobsolete behind; scutal lobes dark brown, paler laterally; scutellum and postnotum dark brown. Pleura chiefly dark brown, variegated by pale yellowish white, the latter including only the dorsopleural region and the pteropleurite. Halteres pale, the knobs infuscated. Legs with the fore coxæ dark brown, the remaining coxæ and all trochanters obscure yellow; remainder of legs broken. Wings subhyaline, with a heavy brown costal pattern, arranged as in the group, leaving pale areas in the outer ends of cells R_2 and R_3; veins pale brown, darker in the infuscated costal region. Venation: Rs with a conspicuous loop at origin, the spur relatively short; forks of medial field deep.

Abdominal segments obscure yellow, their caudal margins narrowly infuscated, the hypopygium chiefly pale. Male hypopygium (Plate 2, fig. 26) with the median region of the tergite, *9t*, produced into a low triangular lobe, the lateral portions blackened but smooth. Dististyles, *id*, and phallosome, *p*, shaped as illustrated. Region of basistyle not at all produced, the sternal region, *9s*, with a low tubercle on either side, these set with a brush or crown of about six flattened spinous setæ.

MINDANAO, Davao district, Mount Apo, Seliban River, altitude 6,500 feet, September 11, 1930 (*C. F. Clagg*) ; holotype, male.

The small size and structure of the male hypopygium readily serve to separate the present fly from allied forms.

DOLICHOPEZA (NESOPEZA) SETISTERNATA sp. nov. Plate 1, fig. 6; Plate 2, fig. 27.

Belongs to the *gracilis* group; general coloration pale yellow; mesonotal præscutum with three reddish brown stripes; pleura yellow, with a broken dorsal longitudinal stripe; legs pale, the tips of femora and tibiæ narrowly darkened; male hypopygium with the region of the basistyle not produced, the armature of the basistyle-sternite consisting of numerous elongate setæ.

Male.—Length, about 8 to 8.5 millimeters; wing, 8 to 9.

Female.—Length, about 9 to 10 millimeters; wing, 9 to 9.3.

Frontal prolongation of head short, brownish black; palpi paler brown. Antennæ with the scapal segments pale brown; basal flagellar segments pale brown, the outer segments darker; flagellar segments elongate-cylindrical, the subterminal verticil unusually small, not or but slightly exceeding the pubescence. Head brownish gray, more yellowish in front.

Mesonotal præscutum obscure yellowish white, with three reddish brown stripes, the median one divided by a darker median vitta; scutal lobes pale brown, the cephalic-lateral portion marked with darker; posterior sclerites of mesonotum more testaceous brown. Pleura yellow, with an interrupted dorsomedian brown stripe, extending from the cervical sclerites across the anepisternum and dorsal pleurotergite, interrupted on the pteropleurite. Halteres obscure yellow, the knobs infuscated. Legs with the coxæ and trochanters pale yellow; femora yellow, the tips narrowly and weakly infuscated; tibiæ whitish, the tips very narrowly and indistinctly dark; tarsi snowy white, the outer segments more infumed. Wings (Plate 1, fig. 6) subhyaline, with the usual dark pattern of the group, this somewhat paler brown than in some allied species; no dark cloudings beyond

caudal level of vein M except across the postarcular region; veins pale yellow, darker in the clouded areas. Venation: Medial forks deep.

Abdomen dark brown, the tergites variegated with obscure yellow before their caudal margins; basal sternites more extensively yellow; subterminal segments more uniformly darkened; hypopygium pale yellowish brown. Females with the tergites more uniformly darkened, the sternites yellow, with narrow transverse darkenings. Male hypopygium (Plate 2, fig. 27) with the lateral lobes of the tergite, *9t*, low, on their ventral face with a comb of blackened points. Region of sternite, *9s*, and basistyle provided with long coarse setæ only. Inner dististyle, *id*, large, suboval in outline, the margin with delicate setæ which pass into a group of four or five short spines near apex of style.

MINDANAO, Davao district, Mount Apo (*C. F. Clagg*); holotype, male, Seliban River, altitude 7,000 feet, September 3, 1930; allotype, female, Sibulan River, 7,000 to 8,000 feet, September 21, 1930; paratypes, 1 male, 2 females, Seliban River, 6,500 feet, September 11, 1930; 1 male, 1 female, with the allotype; 1 male, 2 females, Mainit River, 7,000 feet, September 15, 1930; 1 male, 2 females, Bakraeyon, 8,000 feet, September 16, 1930.

DOLICHOPEZA (NESOPEZA) QUADRIFILA sp. nov. Plate 1, fig. 7; Plate 3, fig. 28.

Belongs to the *cuneata* group, *cinctitarsis* subgroup; male hypopygium with the tergite long and narrow, the apex with a deep U-shaped median notch, each lateral lobe at apex split into two slender branches.

Male.—Length, about 10 millimeters; wing, 11.5.

Female.—Length, about 10 millimeters; wing, 12.

Frontal prolongation of head yellowish brown; palpi darker. Antennæ dark brown, the scapal segments yellow; flagellar segments elongate-cylindrical. Head dark brown; anterior vertex wide.

Mesonotum pale brown, the præscutum with three scarcely evident more yellowish stripes; scutal lobes and posterior sclerites of mesonotum darker brown. Pleura testaceous brown above, paling almost to whitish on the ventral pleurites. Halteres elongate, black. Legs with the coxæ and trochanters pale, the fore coxæ slightly more infuscated; femora brownish black; tibiæ black, the genua restrictedly whitened; tarsi snowy white, the basitarsi extensively darkened medially, as in the *cuneata* group. Wings (Plate 1, fig. 7) with a dusky tinge, the oval stigma dark brown; somewhat brighter areas before and beyond the stigma; veins dark brown. Venation: Cell M_4 narrower at

base than at outer end, as in the group; cell 2d A very narrow, with a distinct vestige of a fold or third anal vein behind it.

Abdomen dark brown, ringed with obscure yellow on basal third; outer segments more uniformly darkened; hypopygium chiefly obscure yellow, especially the conspicuous tergites. Male hypopygium (Plate 3, fig. 28) with the tergite, *9t*, very long and narrow, as in the subgroup, the apex with a deep U-shaped median notch; each lateral lobe split at tip into a shorter outer and a somewhat longer inner and more ventral branch, all branches slightly expanded and more or less truncated at their tips.

MINDANAO, Davao district, Mount Apo (*C. F. Clagg*); holotype, male, allotype, female, Bakraeyon trail, altitude 8,000 feet, September 16, 1930; paratype, male, Galog River, altitude 6,000 feet, September 8, 1930.

DOLICHOPEZA (NESOPEZA) BAGOBO sp. nov. Plate 3, fig. 29.

Belongs to the *cuneata* group and subgroup; antennæ (male) relatively short, if bent backward not or scarcely exceeding the wing root; male hypopygium with the tergite small, the lateral and sublateral teeth obtuse and separated by a shallow notch; sternite pale, the apex obtuse but entire.

Male.—Length, about 8.5 to 9 millimeters; wing, 10 to 11.

Female.—Length, 10.5 to 11 millimeters; wing, 11.

Frontal prolongation of head yellowish testaceous; palpi light brown, darkened outwardly. Antennæ with the first scapal segment obscure yellow, the remainder brown, passing into dark brown or black; antennæ of moderate length, if bent backward scarcely exceeding the wing root. Head brown, the front brightening to obscure fulvous; a paler occipital spot.

Mesonotal præscutum brown, with three brighter, more reddish brown, stripes; scutum dark brown, the median area paler, the lobes variegated with reddish brown areas; scutellum and postnotum brown. Pleura obscure yellow. Halteres elongate, black. Legs with the coxæ and trochanters testaceous yellow, the latter with a black spot on ventral face; femora and tibiæ brownish black, the genua very restrictedly whitened; tarsi white, the central portion of the basitarsus blackened. Wings with a faint brownish tinge, the small oval stigma dark brown; narrow dark seams along the cord; veins brownish black. Venation: Forks of medial field deep.

Abdominal tergites bicolorous, black, the central portions of the individual segments obscure yellow; subterminal segments

more uniformly darkened; hypopygium obscure yellow; sternites more uniformly yellow. Male hypopygium (Plate 3, fig. 29) with the tergite, *9t*, relatively small, the margin toothed about as illustrated. Styli, *d*, as shown. Ninth sternite pale, appearing as a concave sheath, the apex obtuse, entire, and provided with abundant short setæ.

MINDANAO, Davao district, Mount Apo (*C. F. Clagg*); holotype, male, Mainit River, altitude 6,500 feet, September 10, 1930; allotype, female, in copula with type; paratypes, 1 male, 1 female, Galog River, 6,000 feet, September 1, 1930; 1 female, Tio Ridge, 6,500 feet, September 5, 1930.

Dolichopeza (*Nesopeza*) *bagobo* is named from one of the native tribes living near Mount Apo. The species is most nearly allied to *D.* (*N.*) *cuneata* Edwards (Borneo) and *D.* (*N.*) *angustaxillaris* Alexander (Luzon), the three species being most readily separated by the structure and toothing of the ninth tergite of the male hypopygium.

CYLINDROTOMINÆ

STIBADOCERA OPALIZANS sp. nov. Plate 1, fig. 8.

Size large (wing, male, 9 millimeters; antenna, 12); head blue-black, punctate behind; antennal flagellum entirely dark; mesonotum pale reddish brown, the præscutum with three impunctate reddish stripes, the whole surface with light blue to opalescent reflexions; coxæ and femoral bases yellow, remainder of legs black; wings with a strong blackish tinge; abdomen with the basal segment light yellow, the remaining tergites black.

Male.—Length, about 8 millimeters; wing, 9; antenna, about 12.

Female.—Length, about 6 millimeters; wing, 6.5; antenna, about 1.6.

Antennæ with the entire flagellum dark brown. Head deep metallic blue, with coarse punctures on the posterior vertex and occiput.

Mesonotal præscutum with the interspaces light brown, coarsely punctured, the usual three stripes reddish, smooth, the entire surface with opalescent to blue reflections; posterior sclerites of mesonotum reddish, with similar opalescent reflections. Pleura chestnut-red, with coarse punctures, the ventral sternopleurite and meron glabrous, the surface of the pleura with opalescent reflections; dorsopleural region light yellow. Halteres dark brown, the extreme base of stem light yellow. Legs with the coxæ and trochanters yellow; femora dark brown, the base more

yellow; remainder of legs black. Wings (Plate 1, fig. 8) with a strong blackish tinge, the costal margin darker; veins brownish black. Venation: Outer section of Rs subequal to or slightly shorter than r-m; free tip of Sc_2 variable in position, in cases almost as far distad as the fork of R_{2+3}.

Abdomen with the basal segment light yellow; remainder of abdomen dark brown or black, including the hypopygium, the basal sternites light yellow.

The female that I am referring here has the thorax much darker, blackish, with blue-black reflections, the posterior third of the præscutum more reddish.

MINDANAO, Davao district, Mount Apo, Lino Lake and Kidapawan trail from the lake, altitude 7,000 to 8,000 feet, September 19 to 21, 1930 (*C. F. Clagg*); holotype, male; allotype, female; paratypes, 4 males.

Stibadocera opalizans is generally similar to *S. metallica* Alexander (Java) and *S. fasciata* Edwards (Borneo), differing chiefly in details of coloration. I am considering all three as representing closely allied vicarious species rather than as being subspecies, as was done by Edwards. The three form a group of closely allied forms that are very different from the only other known Philippine species of the genus, *S. pumila* Alexander (Luzon).

LIMONIINÆ

LIMONIINI

HELIUS (EURHAMPHIDIA) ATÁ sp. nov. Plate 1, fig. 9

Mesonotal præscutum ocherous, narrowly darkened medially; femora light brown, the tips paling to dirty white; tibial bases not brightened, the tips broadly snowy white.

Female.—Length, about 5.5 millimeters; wing, 5.3.

Rostrum a little longer than the head, brown, the palpi dark brown. Antennæ with the scapal segments black, the basal two or three flagellar segments obscure yellow, the remaining segments black. Head light gray.

Pronotum buffy brown, darker medially. Mesonotal præscutum ocherous, with a narrow dark brown median stripe, the scutal lobes similarly darkened. Pleura ocherous yellow. Halteres pale, the knobs weakly infuscated. Legs with the coxæ and trochanters yellow; femora light brown, the tips paling very gradually and insensibly to dirty white; tibiæ brown, the bases not or scarcely brightened, the tips broadly snowy white, the amount greater on the fore tibiæ where about one-third

is included, narrowest on the posterior tibiæ where nearly one-fourth is brightened; tarsi snowy white, the terminal segments dark brown. Wings (Plate 1, fig. 9) with a whitish tinge, the stigma and apex a little darker; veins pale brown. Venation: Sc_2 ending a short distance beyond r-m; cell 1st M_2 subrectangular, with m-cu at or beyond midlength.

Abdomen dark brown, the sternites more yellowish.

MINDANAO, Davao district, Mount Apo, Mainit River, altitude 7,000 to 8,000 feet, September 15 to 21, 1930 (*C. F. Clagg*); holotype, female; paratype, female.

The specific name, *atá*, is that of a local tribe. The Philippine species of the genus *Helius* may be separated by means of the following key:

Key to the Philippine species of Helius St. Fargeau.

1. Wings with the r-m crossvein connecting with Rs before the fork .... 2.
   Wings with the r-m crossvein connecting with R_{4+5}, beyond the fork of Rs. (*Helius* St. Fargeau, s. s.) .... 8.
2. Rostrum elongate, about equal in length to the thorax; wings with a reticulate brown pattern. (*Rhampholimnobia* Alexander.) (Luzon; Mindanao; Borneo; Java.) .... *H.* (*R.*) *reticulatus* Alexander.
   Rostrum short, a little longer than the head; wings unmarked, except for the stigmal area, when this is present. (*Eurhamphidia* Alexander.) .... 3.
3. Femoral tips dirty white to abruptly snowy white .... 4.
   Femoral tips not at all brightened .... 7.
4. Tips of femora dirty white, not abruptly brighter than the remainder; bases of tibiæ not conspicuously brightened. (Mindanao.) *H.* (*E.*) *atá* sp. nov.
   Tips of femora abruptly snowy white; bases of tibiæ similarly brightened .... 5.
5. Male hypopygium with the lateral arms of the tergite bearing a conspicuous slender lateral branch near base. (Luzon.) *H.* (*E.*) *diacanthus* Alexander.
   Male hypopygium with the lateral arms of the tergite simple, without branches .... 6.
6. Male hypopygium with the outer dististyle provided with abundant delicate setulæ. (Mindanao.) .... *H.* (*E.*) *indivisus* Alexander.
   Male hypopygium with the outer dististyle entirely glabrous. (Mindanao.) .... *H.* (*E.*) *glabristylatus* sp. nov.
7. Size large (wing, female, over 6 millimeters); rostrum relatively elongate, about one-half longer than the remainder of head; tips of tibiæ narrowly white, including less than the outer fourth of the mid-tibiæ. (Luzon.) .... *H.* (*E.*) *fuscofemoratus* Alexander.
   Size smaller (wing, female, under 5 millimeters); rostrum short, only a little longer than remainder of head; tips of tibiæ broadly white, including more than the outer third of mid-tibiæ. (Luzon; Mindanao.) .... *H.* (*E.*) *nigrofemoratus* Alexander.

8. Anterior branch of Rs fused apically with R_{1+2}, closing cell R_1........ 9.
   Anterior branch of Rs reaching the wing margin as a distinct unit.... 10.
9. General coloration dark brown. (Luzon; Mindanao.)
   H. (*H.*) *trianguliferus* Alexander.
   General coloration pale ocherous. (Mindanao.)
   H. (*H.*) *apoensis* sp. nov.
10. Anterior branch of Rs very strongly arcuated at origin, beyond base running generally parallel and close to R_{1+2}; m-cu slightly beyond the fork of M; cell 1st M_2 long-rectangular.. 11.
    Anterior branch of Rs gently arcuated at origin, diverging gradually from the posterior branch; m-cu at fork of M; cell 1st M_2 nearly square to subpentagonal. (Luzon.)
    H. (*H.*) *argyrosterna* Alexander.
11. Antennæ (male) elongate, if bent backward extending to beyond the root of the halteres. (Mindanao.)........ *H.* (*H.*) *procerus* Alexander.
    Antennæ (male) short, if bent backward not reaching the wing base. (Luzon.) .... *H.* (*H.*) *arcuarius* Alexander.

HELIUS (EURHAMPHIDIA) GLABRISTYLATUS sp. nov. Plate 1, fig. 10.

Closely related to *H.* (*E.*) *indivisus* Alexander, differing especially in the details of coloration and in the glabrous outer dististyle of the male hypopygium.

Male.—Length, about 3.7 millimeters; wing, 4.5.

Female.—Length, about 4.5 millimeters; wing, 4.5.

Head dark gray. Mesonotal præscutum chiefly dark brown, the lateral margins and humeral region extensively obscure yellow; scutal lobes brownish black; scutellum testaceous. Legs dark brown, the femoral tips broadly and abruptly, the tibial bases narrowly snowy white; tips of all tibiæ relatively narrowly snowy white, the amount subequal on all legs and only about one-half as wide as in *H. indivisus.* Venation as shown (Plate 1, fig. 10). Male hypopygium with the lateral arms of the tergite simple, as in *indivisus.* Outer dististyle entirely glabrous, without the thick covering of setulæ of *indivisus.*

MINDANAO, Davao district, Mount Apo, Kidapawan trail from Lake Lino, altitude 7,000 to 8,000 feet (*C. F. Clagg*); holotype, male; allotype, female; paratypes, 2 males, September 20, 1930; paratypes, 3 females, September 21 to 30, 1930.

HEXATOMINI

ULA MINDANICA sp. nov. Plate 1, fig. 11; Plate 3, fig. 30.

General coloration black, more or less pruinose; antennæ relatively short; halteres and legs chiefly blackened; wings with a strong dusky tinge, the costal border more blackish; cell 1st M_2 of wings very small.

Male.—Length, about 6 to 7 millimeters; wing, 8 to 8.5.

Female.—Length, about 6.5 to 7.5 millimeters; wing, 8 to 9. Rostrum brownish gray; palpi black. Antennæ black throughout; in male, of moderate length only, if bent backward extending to shortly beyond the wing root; flagellar segments long-oval, with unilaterally arranged verticils that are about as long as the segments. Head dark brown, pruinose.

Mesonotum black, sparsely pruinose; median region of scutum and the scutellum more pollinose with yellow. Pleura black, pruinose with gray, especially on the ventral pleurites. Halteres black, the base of stem restrictedly yellow. Legs with the coxæ obscure yellow, the bases weakly pruinose; trochanters brownish yellow; femora black, the bases yellow; remainder of legs black. Wings (Plate 1, fig. 11) with a strong dusky tinge, the costal region and stigma even more blackish; veins and macrotrichia black. Macrotrichiæ of cells relatively abundant beyond the cord, in the more basal cells restricted to the centers of the cells, their distribution about as illustrated; macrotrichia of veins unusually long and slender. Venation: Cell 1st M_2 very small, vein M_{1+} beyond it usually more than four times the length of the cell.

Abdomen black, sparsely pruinose, the basal segments a little paler; hypopygium chiefly darkened. Male hypopygium (Plate 3, fig. 30) with the dististyle, *d*, single, bearing about a dozen black spines. Interbasal process, *i*, a slender rod, slightly expanded at outer end. Gonapophyses, *g*, nearly as long as the interbases but more slender, acute at tips. Ædeagus, *a*, large, compressed on basal and central portions.

MINDANAO, Davao district, Mount Apo (*C. F. Clagg*); holotype, male; allotype, female; Sibulan River, altitude 7,000 to 8,000 feet, September 21, 1930; paratypes, 1 male, Mainit River, 6,000 feet, September 24, 1930, 1 female, 7,000 feet, September 15, 1930; 3 males, 1 female, Kidapawan trail from Lake Lino, 7,000 to 8,000 feet, September 20, 1930; 1 male, Seliban River, 7,000 feet, September 11, 1930.

Ula mindanica is most closely allied to *U. javanica* Alexander (Java), differing in the details of coloration of the body, halteres, and legs, together with slight details of venation and trichiation, especially the long macrotrichia of the wing veins.

PSEUDOLIMNOPHILA LEGITIMA sp. nov. Plate 1, fig. 12; Plate 3, fig. 31.

General coloration yellow, the mesonotum dark brown; antennæ short in both sexes; legs chiefly brownish black, the tarsi in

cases a trifle paler; wings with the costal fringe short; cell M_1 present.

Male.—Length, about 5.5 to 6.5 millimeters; wing, 7 to 7.5.

Female.—Length, about 7 to 7.5 millimeters; wing, 7 to 8.

Rostrum obscure yellow to brown; palpi black. Antennæ relatively short in both sexes, black throughout; flagellar segments cylindrical, with very long, conspicuous verticils on the outer flagellar segments. Head dark gray; anterior vertex nearly twice as wide as the diameter of the scape.

Pronotum and mesonotum dark brown, the humeral and lateral regions of the præscutum yellow; median area of scutum and base of scutellum obscure yellow; central portion of mediotergite blackened, the lateral areas and the pleurotergite yellow. Pleura yellow, the dorsopleural region and areas surrounding the wing root usually dark brown; dorsal sternopleurite and anepisternum, in cases weakly suffused with brown. Halteres brown, the stem brighter. Legs with the coxæ and trochanters yellow; femora brownish black, the bases obscure yellow; tibiæ brownish black; tarsi brown to brownish black. Wings (Plate 1, fig. 12) with a brownish tinge, iridescent; stigma and a marginal seam in the radial field to vein R_4 dark brown; veins brownish black. Costal fringe relatively short. Venation: Sc_1 ending just beyond r-m, Sc_2 nearly opposite the fork of Rs; R_2 a little shorter than R_{2+3}; R_3 relatively short, sinuous, diverging from vein R_4, cell R_3 at margin subequal to cell R_2; cell M_1 present, shorter than its petiole; m-cu at or close to fork of M.

Abdominal tergites dark brown, brightened laterally; sternites paler, obscure yellow; a narrow dark brown subterminal ring; hypopygium with the basistyli obscure yellow. Male hypopygium (Plate 3, fig. 31) with the dististyles long and slender, the outer, *od,* nearly straight, the slender tip curved to an acute point.

MINDANAO, Davao district, Mount Apo (*C. F. Clagg*); holotype, male; allotype, female, Mainit River, altitude 6,500 feet, September 14, 1930; paratopotypes, 44 males and females, 6,000 to 6,500 feet, September 9 to 23, 1930; paratypes, 1 male, Seliban River, 7,000 feet, September 11, 1930; 1 female, Poraka River, 6,500 feet, September 8, 1930; 1 female, Sibulan River, 6,000 feet, August 31, 1930; 7 males and females, Galog River, 6,000 feet, September 3 to 8, 1930; 1 female, Galog River trail, 5,000 to 6,000 feet, September 12, 1930.

The present species is readily told by the diagnostic characters listed. The known Philippine species of *Pseudolimnophila* may be separated by the following key:

Key to the Philippine species of Pseudolimnophila.

1. Cell M_1 of wings present .... 2.
   Cell M_1 of wings lacking .... 3.
2. Legs black, the tarsi abruptly light yellow; wings narrow, the margins of outer radial cells not suddenly darkened. (Luzon.)
   P. luteitarsis Alexander.
   Legs black, the tarsi only slightly if at all paler than the tibiæ; wings broad, the outer margins of cells R_2 and R_3 suddenly darkened. (Mindanao.) .... *P. legitima* sp. nov.
3. Wings broad, the outer radial cells narrowly dark brown; tarsi black. (Mindanao.) .... *P. illegitima* sp. nov.
   Wings narrow, the outer radial cells not darkened; tarsi paling to golden yellow. (Mindanao.) .... *P. auripes* sp. nov.

PSEUDOLIMNOPHILA ILLEGITIMA sp. nov. Plate 1, fig. 13.

Male.—Length, about 6.5 to 7 millimeters; wing, 7 to 7.2.

Female.—Length, about 8 millimeters; wing, 7.5.

Very similar in all respects to *P. legitima* sp. nov., differing only in the total loss of cell M_1 of the wings. Legs black, the tarsi scarcely if any brightened. Wings (Plate 1, fig. 13) with a strong brownish yellow tinge, cells C and Sc clearer yellow; stigma and a conspicuous marginal seam in cells R_2 and R_3 dark brown; veins brownish black. Venation: Anterior branch of Rs extending generally parallel to R_4, cell R_3 at margin much narrower than cell R_2; cell M_1 lacking; m-cu close to inner end of cell 1st M_2.

MINDANAO, Davao district, Mount Apo (*C. F. Clagg*); holotype, male, Mainit River, altitude 6,000 feet, September 9, 1930; allotype, female, Galog River, 6,000 feet, September 7, 1930; paratopotypes, 2 males, 6,000 to 6,500 feet, September 14 to 24, 1930; paratype, 1 male, with the allotype, September 8, 1930.

PSEUDOLIMNOPHILA AURIPES sp. nov. Plate 1, fig. 14.

Male.—Length, about 6 to 7.5 millimeters; wing, 7 to 8.3.

Female.—Length, about 8.5 to 9 millimeters; wing, 8 to 9.

Generally similar to *P. illegitima* sp. nov., in the loss of cell M_1, differing most conspicuously in the yellow tarsi and the much narrower wings. Antennæ short in both sexes, black throughout, with long conspicuous verticils. Head black, with a sparse pruinosity.

Mesonotum chiefly dark brown, the humeral and lateral portions of the præscutum more yellowish; in cases, the entire

præscutum more uniformly reddish yellow. Pleura obscure yellow, the dorsopleural region more infuscated. Halteres brown. Legs with the coxæ and trochanters obscure yellow, the fore coxæ more infuscated; femora brownish black; tibiæ brown to pale brown; tarsi more golden yellow. Wings (Plate 1, fig. 14) long and narrow, tinged with brown, cells C and Sc a little darker; stigma pale brown; veins dark brown; no darkening in outer ends of cells R_2 and R_3. Venation: R_{2+3+4} long and strongly arcuated; anterior branch of Rs running nearly parallel to vein R_3; cell M_1 lacking; m-cu near inner end of cell 1st M_2; cell 2d A narrow. Abdominal tergites brownish black, the sternites obscure yellow.

MINDANAO, Davao district, Mount Apo (*C. F. Clagg*); holotype, male, Galog River, altitude 6,000 feet, September 8, 1930; allotopotype, female; paratopotypes, several of both sexes, September 7 to 26, 1930; paratypes, several of both sexes, Mainit River, 6,000 to 6,500 feet, September 9 to 24, 1930. One specimen is labelled as having been taken on grass at hot springs.

LIMNOPHILA (LIMNOPHILA) BITUMINOSA sp. nov. Plate 1, fig. 15; Plate 3, fig. 32.

General coloration coal-black, with a very sparse reddish brown pollen, the black coloration including the entire thoracic pleura and abdomen; legs chiefly dark brown, the tips blackened; wings cream-colored, with a very heavy fasciate dark brown pattern.

Male.—Length, about 6.5 to 7 millimeters; wing, 6.8 to 7.5.

Female.—Length, about 7.5 millimeters; wing, 7.8.

Rostrum and palpi black. Antennal scape black, the flagellar segments more brownish black; antennæ short in both sexes; basal flagellar segments short-oval, becoming more elongate outwardly and here provided with long conspicuous verticils. Head black, with a reddish brown pollen.

Thorax chiefly black, with a sparse reddish brown pollen. Halteres pale yellow. Legs with the coxæ brownish black, the fore coxæ paler apically; trochanters obscure yellow; remainder of legs chiefly brownish black, the femoral bases obscure yellow; in cases the femora are dark brown, with the tips blackened, and with a more or less distinct paler subterminal ring; legs with conspicuous suberect setæ. Wings (Plate 1, fig. 15) cream-colored, with a very heavy dark brown crossbanded pattern, the broadest fasciæ at level of origin of Rs and along the cord; other areas include the wing tip, across the middle of the outer radial field and as a postarcular darkening; individual clouds in basal half of cell 2d A and as a confluent series of clouds in cell M;

veins pale yellow, darker in the clouded areas. The degree of the dark pattern varies in different individuals, in some being lighter, with the dark seam at outer end of cell 1st M_2 widely separated from the band at the cord; in the other extreme of specimens, the dark areas are so extensive as virtually to cover the entire ring. Costal fringe long and conspicuous. Venation: Sc relatively short, Sc_1 ending about opposite the fork of Rs, Sc_2 close to its tip; R_2 faint, considerably shorter than R_{1+2} cell M_1 present; m-cu at or beyond midlength of cell 1st M_2; anterior arculus preserved.

Abdomen, including the hypopygium, black. Male hypopygium (Plate 3, fig. 32) with the outer dististyle, *od*, a simple curved rod, narrowed to an acute point, the outer surface with abundant erect setæ. Gonapophyses, *g*, appearing as flattened blades. Interbasal processes, *i*, blackened, capitate.

MINDANAO, Davao district, Mount Apo (*C. F. Clagg*); holotype, male, Kidapawan trail from Lake Lino, altitude 7,000 to 8,000 feet, September 20, 1930; allotype, female, Lino Lake, 8,000 feet, September 19, 1930; paratopotypes, 25 of both sexes; paratypes, 10 males, with the allotype.

Limnophila bituminosa is most closely allied to *L.* (*L.*) *benguetana* Alexander (Luzon), *L.* (*L.*) *guttularis* Edwards (Borneo) and *L.* (*L.*) *murudensis* Edwards (Borneo), differing from all in the uniformly blackened body and unusually heavy wing pattern. It is evident that females are very rare in this particular group of the subgenus, the present large series including only two of this sex.

PILARIA LEUCOPODA sp. nov. Plate 1, fig. 16; Plate 3, fig. 33.

General coloration of mesonotum brown, the præscutum more obscure reddish; pleura ocherous gray, striped longitudinally with black; tarsi chiefly white; wings with a strong dusky tinge; anterior branch of Rs short, cell R_3 at margin correspondingly widened; cell M_1 lacking; male hypopygium with the lobes of the tergite setiferous; longest gonapophysis toothed along margin.

Male.—Length, about 6 to 7 millimeters; wing, 8 to 8.5.

Rostrum and palpi black. Antennæ short; scapal segments black; basal segments of flagellum obscure yellow, the outer segments passing into dark brown; basal segments of flagellum short and crowded, with short verticils; outer segments more elongated, with long conspicuous verticils. Head dark brownish gray, the orbits narrowly light gray; anterior vertex broad.

Pronotum large, dark in color, with a grayish white pruinosity. Mesonotal præscutum obscure reddish, with vague indica-

tions of four darker stripes on posterior half, the intermediate pair of these stripes continued as a central darkening more or less to the cephalic margin of the sclerite; pseudosutural foveæ large; posterior sclerites of mesonotum dark brown. Pleura light ocherous gray, conspicuously variegated with velvety black, this color appearing chiefly as two interrupted longitudinal stripes, the more dorsal including the propleura and ventral anepisternum, the ventral stripe including the ventral sternopleurite and the hypopleural and meral regions. Halteres pale, the knobs weakly darkened. Legs with the coxæ obscure yellow, the fore coxæ more darkened; trochanters obscure yellow; femora obscure yellow basally, passing into brown; tibiæ brown; tarsi chiefly white, most extensive on the posterior tarsi, where all the basitarsus is included, least extensive on the fore tarsi where the outer fifth or sixth of the basitarsus is brightened. Wings (Plate 1, fig. 16) with a strong dusky tinge, the oval stigma darker brown; longitudinal subhyaline streaks in the basal radial, medial, cubital, and anal cells; veins dark brown. Venation: Sc_1 ending opposite or just beyond the fork of Rs, Sc_2 some distance from its tip; R_2 close to fork of R_{3+4}, sometimes before this fork, in other cases with R_2 subequal to R_{2+3}; anterior branch of Rs unusually short, as in *phœnosoma*, the cell at margin very wide; cell M_1 lacking; m-cu at near one-third the length of cell 1st M_2.

Abdominal tergites black, variegated with obscure orange-yellow on the posterior portions of the segments; outer segments more uniformly blackened; sternites obscure yellow, the bases of the individual segments narrowly darkened. Male hypopygium (Plate 3, fig. 33) with the caudal margin of the tergite, *9t*, produced into two conspicuous submedian setiferous lobes that are separated by a narrow U-shaped notch. Outer dististyle, *od*, slender, glabrous, terminating in a small oval recurved flap or operculum. Inner dististyle a broad mitten-shaped lobe, narrower than in *phœnosoma*. Longest gonapophysis, *g*, terminating in an acute point, the margin with a few conspicuous denticles.

MINDANAO, Davao district, Mount Apo (*C. F. Clagg*); holotype, male, Mainit River, altitude 6,000 feet, September 4, 1930; paratopotypes, 3 males, 6,000 to 6,500 feet, September 14 to 22, 1930.

Pilaria leucopoda is readily told from *P. phœnosoma* Alexander (Luzon), its closest ally, by the white tarsi, as well as the very different structure of the male hypopygium.

ERIOCERA NIGRONOTATA sp. nov. Plate 1, fig. 17.

Belongs to the *pyrrhochroma* group; general coloration obscure fulvous; sides of mesonotum and the pleura with small velvety-black spots; wings with a yellowish brown tinge; cell M_1 present.

Male.—Length, about 9 to 11 millimeters; wing, 10.5 to 13.

Rostrum and palpi black. Antennæ short; scapal segments obscure yellow; flagellum black. Head dark gray, the center of the vertex darkened.

Mesonotal præscutum obscure fulvous, with two velvety-black lateral spots, one behind the pseudosutural foveæ, the other at the suture; posterior sclerites of mesonotum brown, slightly plumbeous. Pleura yellow, with a velvety-black spot between the anepisternum and sternopleurite, with a smaller spot below and in front of the wing root. Halteres infuscated, the base of the stem narrowly brightened. Legs with the coxæ and trochanters yellow; femora dark brown, the bases obscure yellow; tibiæ and tarsi dark brown. Wings (Plate 1, fig. 17) with a yellowish brown tinge, the costal region and wing tip slightly more darkened; the actual stigma dark brown but very small, appearing as a seam at outer end of vein R_1; veins brown, paler in the basal and subcostal regions, blacker beyond the cord. Venation: Rs long, in alignment with R_5, the basal section of the latter being obliterated; r-m at fork of Rs; cell R_3 angulated at base; R_2 longer than the upturned R_{1+2}; cell M_1 present, about equal to its petiole; m-cu about its own length beyond the fork of M; distal section of Cu_1 a little longer than m-cu, nearly in alignment with the basal section.

Basal abdominal segments obscure yellow medially, darkened laterally, the outer segments more uniformly velvety black; hypopygium chiefly blackened.

MINDANAO, Davao district, Mount Apo, altitude 6,000 feet, September 4 to 26, 1930 (*C. F. Clagg*); holotype, male; paratype, male.

By Edwards's key to the Old World species of *Eriocera*,[6] the present fly runs to couplet 29, disagreeing in the combination of having cell M_1 present and with black spots on sides of mesonotum; running farther on the basis of presence of cell M_1, the fly runs to couplet 33, disagreeing with both included species. By Edwards's key to the Philippine species of *Eriocera*,[7] the

[6] Ann. & Mag. Nat. Hist. IX 8 (1921) 70–78.

[7] Notulae Entomologicae 6 (1926) 38–39.

present fly runs to couplet 12, disagreeing in the venation, which is that of *pyrrhochroma* and allied species in the Oriental fauna. Such species have the basal section of R_5 obliterated or nearly so and with r-m at or close to the fork of Rs.

ERIOPTERINI

GNOPHOMYIA OBESULA sp. nov. Plate 1, fig. 18; Plate 3, fig. 34.

General coloration black; antennæ (male) elongate, exceeding one-half the length of the body; halteres and legs black; wings with a strong blackish tinge; male hypopygium with the outer dististyle simple, unusually stout; inner dististyle a small simple black spine; ædeagus short.

Male.—Length, about 3.5 millimeters; wing, 4; antenna, about 2.

Rostrum and palpi black. Antennæ black throughout, elongate in male; flagellar segments long-cylindrical, the longest verticils subequal to the segments, the remainder of organ with numerous long, coarse, scattered setæ. Head black.

Thorax black, very sparsely pruinose. Halteres black, the extreme base of stem pale. Legs with the coxæ and trochanters black; remainder of legs brownish black. Wings (Plate 1, fig. 18) with a strong blackish tinge, the stigma scarcely indicated; certain of the veins, especially Cu and the end of Rs, more clouded with brown; veins black. Venation: Sc_1 ending shortly before the level of R_2; Rs in alignment with R_5; r-m at or shortly before the fork of Rs; m-cu at near one-third the length of cell 1st M_2.

Abdomen, including hypopygium, black. Male hypopygium (Plate 3, fig. 34) with the outer dististyle, *od*, unusually stout and tumid, gradually narrowed to a subacute tip, with a few scattered setigerous punctures. Inner style a small acute spine. Ædeagus relatively short.

MINDANAO, Davao district, Mount Apo, Galog River, altitude 6,000 feet, August 31, 1930 (*C. F. Clagg*); holotype, male.

Gnophomyia obesula is most closely allied to *G. macrocera* Alexander (Luzon), differing in the shorter antennæ and, especially, the very different structure of the male hypopygium.

TOXORHINA (TOXORHINA) TUBERCULATA sp. nov. Plate 3, fig. 35.

General coloration of notum gray; rostrum elongate; thoracic pleura dark brown above, paler below; wings with a faint brownish tinge; male hypopygium with the setæ of the mesal face of the basistyle simple; outer dististyle a simple elongate

spine; inner dististyle a flattened blade that bears a small erect tubercle on outer margin of basal half.

Male.—Length, excluding rostrum, about 5 millimeters; wing, 4.6; rostrum, about 4.5.

Rostrum elongate, only a little shorter than the body, black. Antennæ black, the basal segments pruinose. Head light gray.

Pronotum brownish black. Mesonotal præscutum brownish gray medially, the humeral region vaguely brightened; posterior sclerites of mesonotum clearer gray. Pleura with the dorsopleural membrane and dorsal pleurites, including the roots of the wings and halteres, brownish black; ventral pleurites obscure yellow, the ventral sternopleurite again darkened. Halteres brownish black, the extreme base of stem obscure yellow. Legs with the coxæ and trochanters light yellow; femora brown, the bases paler; remainder of legs brownish black. Wings with a faint brownish tinge; veins black. Venation: Cell M_2 open by the atrophy of m.

Abdominal tergites brownish black, the sternites paler. Male hypopygium (Plate 3, fig. 35) with the setæ of the mesal face of the basistyle, *b,* simple. Outer dististyle, *od,* a simple elongate spine from a dilated base. Inner dististyle, *id,* a flattened blade, on basal half of outer margin with a small erect tubercle. Arms of ædeagus, *a,* relatively short.

MINDANAO, Davao district, Mount Apo, Mainit River, altitude 6,500 feet, September 14, 1930 (*C. F. Clagg*); holotype, male.

Toxorhina (*Toxorhina*) *tuberculata* is most readily told from its closest allies, *T.* (*T.*) *duyagi* Alexander (Luzon) and *T.* (*T.*) *montina* Alexander (Luzon), by the structure of the dististyles of the male hypopygium.

ILLUSTRATIONS

[Legend: *a*, ædeagus; *b*, basistyle; *d*, dististyles; *g*, gonapophysis; *i*, interbasal process; *id*, inner dististyle; *od*, outer dististyle; *p*, phallosome; *s*, sternite; *t*, tergite.]

PLATE 1

FIG. 1. *Scamboneura claggi* sp. nov., wing.
2. *Scamboneura citridorsum* sp. nov., wing.
3. *Dolichopeza* (*Dolichopeza*) *atá* sp. nov., wing.
4. *Dolichopeza* (*Nesopeza*) *multiguttula* sp. nov., wing.
5. *Dolichopeza* (*Nesopeza*) *productula* sp. nov., wing.
6. *Dolichopeza* (*Nesopeza*) *setisternata* sp. nov., wing.
7. *Dolichopeza* (*Nesopeza*) *quadrifila* sp. nov., wing.
8. *Stibadocera opalizans* sp. nov., wing.
9. *Helius* (*Eurhamphidia*) *atá* sp. nov., wing.
10. *Helius* (*Eurhamphidia*) *glabristylatus* sp. nov., wing.
11. *Ula mindanica* sp. nov., wing.
12. *Pseudolimnophila legitima* sp. nov., wing.
13. *Pseudolimnophila illegitima* sp. nov., wing.
14. *Pseudolimnophila auripes* sp. nov., wing.
15. *Limnophila* (*Limnophila*) *bituminosa* sp. nov., wing.
16. *Pilaria leucopoda* sp. nov., wing.
17. *Eriocera nigronotata* sp. nov., wing.
18. *Gnophomyia obesula* sp. nov., wing.

PLATE 2

FIG. 19. *Scamboneura claggi* sp. nov., male hypopygium, details.
20. *Scamboneura citridorsum* sp. nov., male hypopygium, details.
21. *Scamboneura subdotata* sp. nov., male hypopygium, details.
22. *Scamboneura opacinotum* sp. nov., male hypopygium, details.
23. *Dolichopeza* (*Dolichopeza*) *atá* sp. nov., male hypopygium, details.
24. *Dolichopeza* (*Nesopeza*) *nigrofemorata* sp. nov., male hypopygium, details.
25. *Dolichopeza* (*Nesopeza*) *productula* sp. nov., male hypopygium, details.
26. *Dolichopeza* (*Nesopeza*) *parvella* sp. nov., male hypopygium, details.
27. *Dolichopeza* (*Nesopeza*) *setisternata* sp. nov., male hypopygium, details.

PLATE 3

FIG. 28. *Dolichopeza* (*Nesopeza*) *quadrifila* sp. nov., male hypopygium, details.
29. *Dolichopeza* (*Nesopeza*) *bagobo* sp. nov., male hypopygium, details.
30. *Ula mindanica* sp. nov., male hypopygium.
31. *Pseudolimnophila legitima* sp. nov., male hypopygium.
32. *Limnophila* (*Limnophila*) *bituminosa* sp. nov., male hypopygium.
33. *Pilaria leucopoda* sp. nov., male hypopygium.
34. *Gnophomyia obesula* sp. nov., male hypopygium.
35. *Toxorhina* (*Toxorhina*) *tuberculata* sp. nov., male hypopygium.

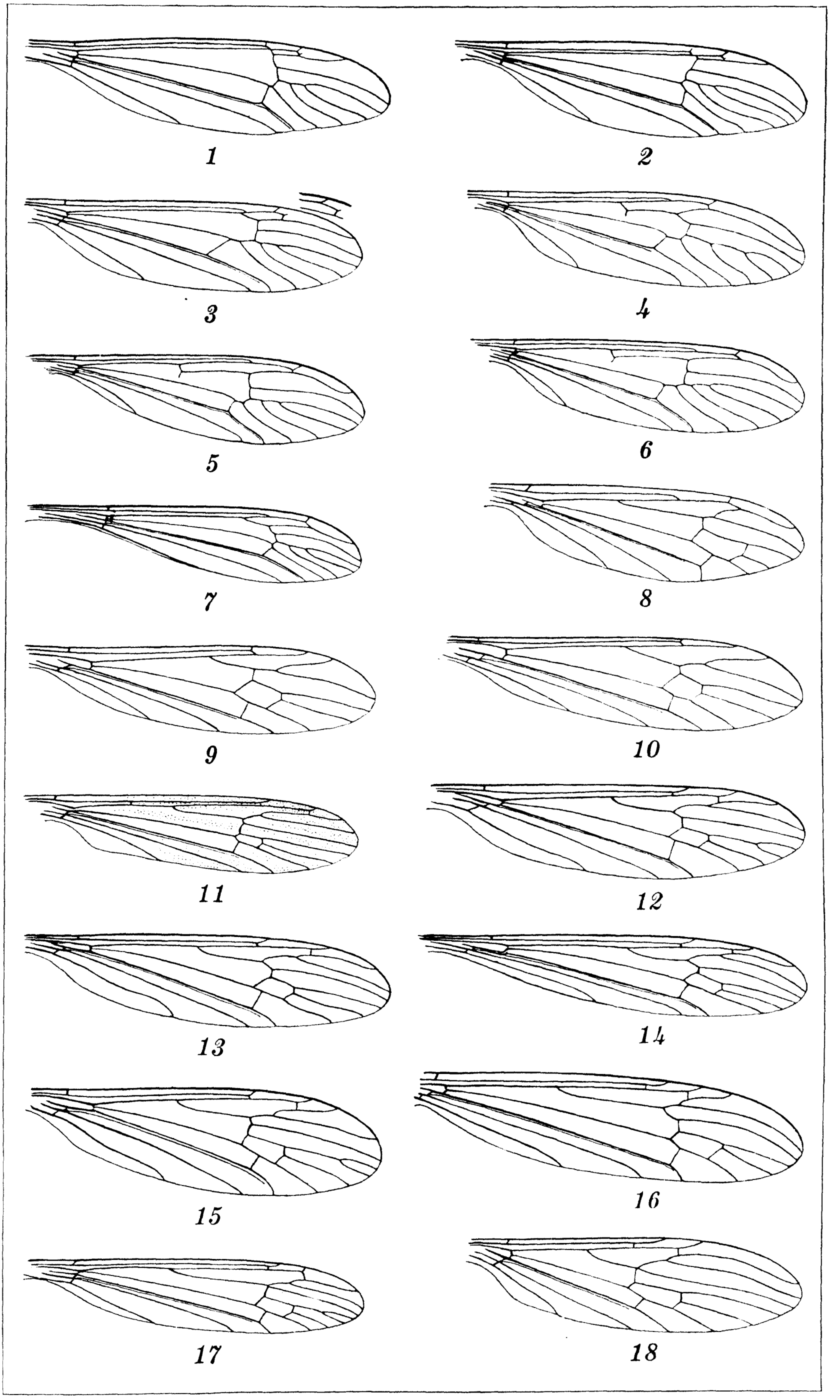

PLATE 1.

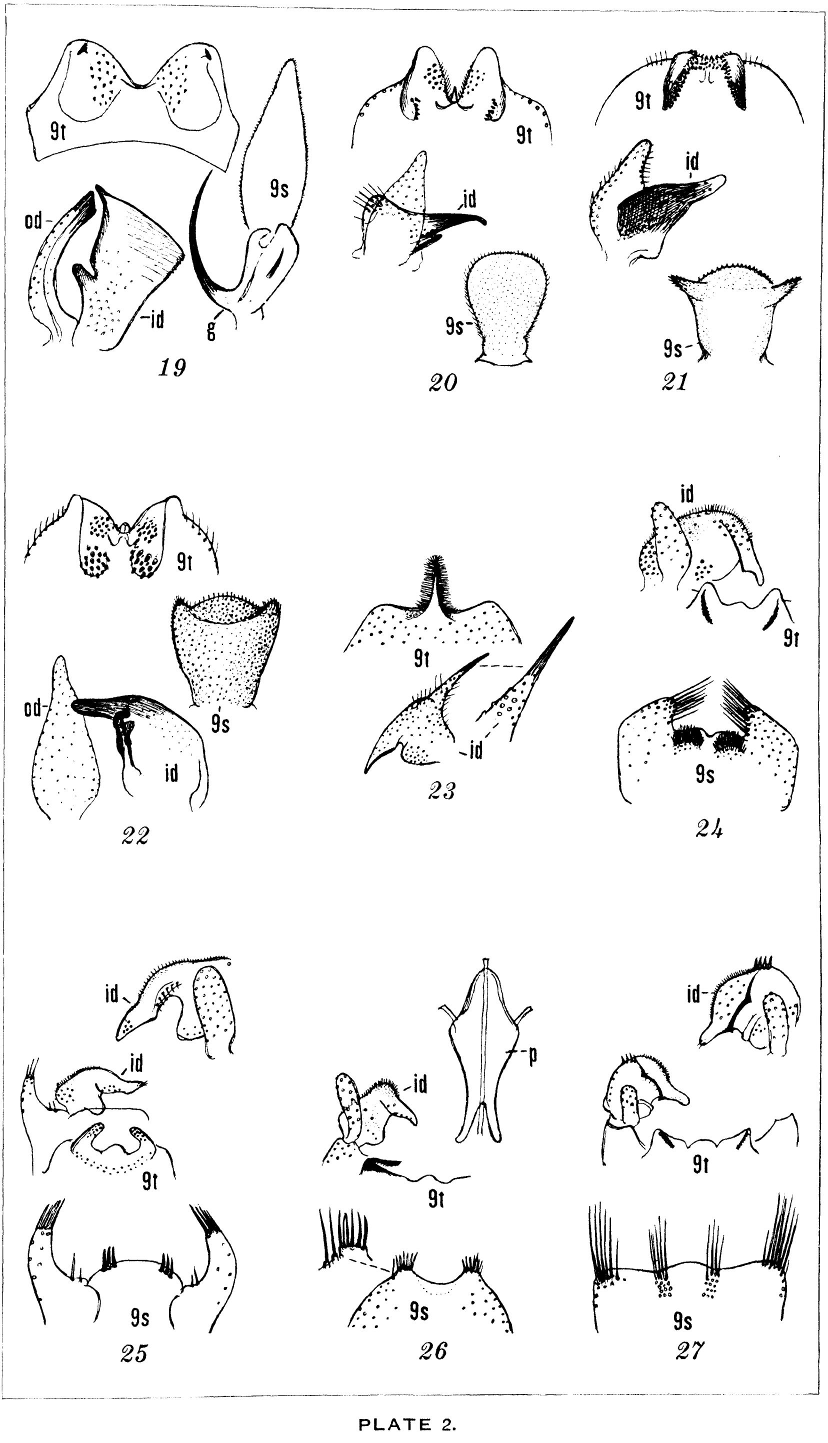
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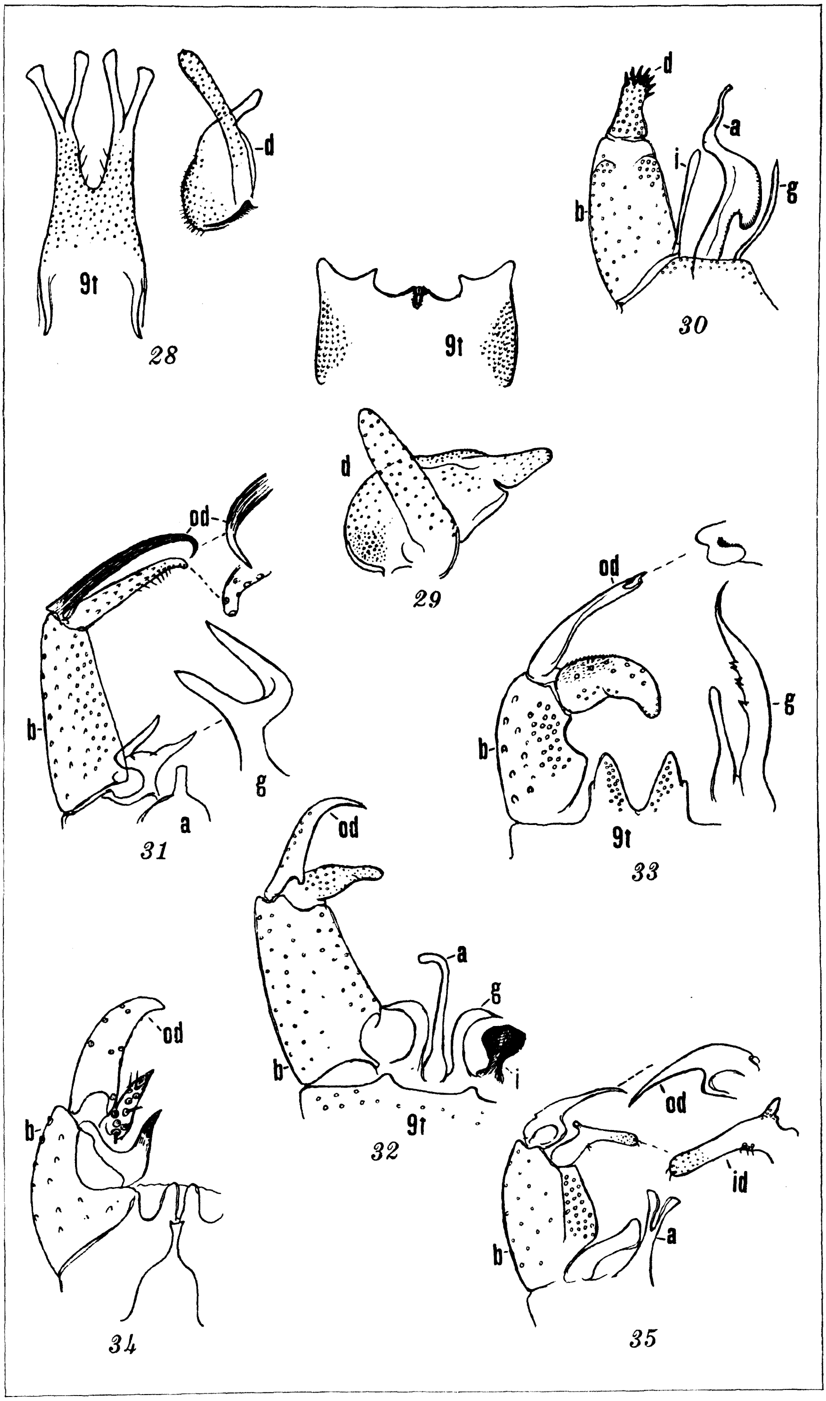
PLATE 2.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THE PHILIPPINE JOURNAL OF SCIENCE

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NEW OR NOTEWORTHY PHILIPPINE ORCHIDS, II

By OAKES AMES

Professor of Botany in Harvard University

and

EDUARDO QUISUMBING

Botanist, Bureau of Science, Manila

TWENTY-NINE PLATES

The present contribution is, like the preceding one,[1] the result of further studies of those orchids in the Philippines that appear to deserve recognition as being new. Five species, which have been described previously, are here recorded and redescribed, one of these from the Archipelago for the first time. Five species and two varieties are here proposed as new. The arrangement of the genera follows the sequence proposed by Pfitzer in Engler and Prantl's "Die natürlichen Pflanzenfamilien." All the illustrations and descriptions have been prepared from living specimens. The colored illustrations and ink sketches were made by Messrs. J. M. Salazar and P. Ramos, draftsmen of the division of botany, Bureau of Science. Unless otherwise indicated in the text, the types of the new species and varieties have been deposited in the herbarium of the Bureau of Science, with the isotypes in the herbarium of the senior author.

Genus AGROSTOPHYLLUM Blume

AGROSTOPHYLLUM LUZONENSE sp. nov. Plates 1, 4, 13, and 14.

Herba epiphytica, caules 21 ad 40 cm longi, ad basim 2 ad 2.5 mm in diametro, fasciculati, teretes, erecti, superne vaginis

[1] Philip. Journ. Sci. 44 (1931) 369.

foliorum haud dilatati; vaginae foliorum imbricatae, persistentes, nitidae, stramineae, prope apicem caulis haud inflatae (in vivo et in sicco), marginibus flavidis; nodi 1 ad 2 cm distantes. Folia usque ad 9 cm longa, prope basim 5 ad 6 mm lata, linearia, acute acuminata, ad basim torta. Inflorescentia terminalis capitata, multiflora, 1.5 ad 2 cm in diametro. Bracteae exteriores inflorescentiam amplectentes, rigidae, lanceolatae, floribus longiores; bracteae florales obtusae, floribus breviores, glumaceae. Pedicelli cum ovario 6 ad 7 mm longi. Sepala lateralia ovato-lanceolata, tenuiter acuminata, obliqua, trinervia, circiter 6 mm longa, ad basim 3 mm lata. Sepalum dorsale simile. Petala lineari-lanceolata, circiter 5 mm longa, ad basim 1.5 mm lata. Labellum carnosum, ad basim leviter saccatum, saccus antice in laminam retusam productus, 7 mm longum; epichilium deltoideo-ovatum, circiter 5 mm longum, 4.5 mm latum, acutum, margine involutum, leviter apiculatum, expansum minute trilobatum. Gynostemium circiter 5 mm longum, rostellum ovatum, sulcatum. Pollinia 8.

An epiphyte; the roots very numerous, 1.5 to 2 mm in diameter. Stems tufted, erect, terete, slender, 21 to 40 cm long, 2 to 2.5 mm in diameter at the base, forming large clumps up to 30 cm in diameter; the nodes 1 to 2 cm distant, light green and entirely covered by the straw-colored persistent leaf sheaths. The leaf sheaths not inflated above both in the living and in the dried specimens, the margins yellowish. Leaves restricted to the upper portion of the stems, distichous, the bases twisted, linear, acutely acuminate, up to 9 cm long, 5 to 6 mm wide at the base, the very apex sharply triapiculate. Inflorescences terminal, capitate, many-flowered, not very dense, composed of short spikes, 1 to 2 cm in diameter; flowers 1 to 3 on a spike, opening simultaneously, about 1 cm across. Peduncles about 5 mm long. Exterior bracts sheathing the inflorescence, rigid, lanceolate, longer than the flowers, the floral ones glumaceous, obtuse, shorter than the flowers. Pedicellate ovary 6 to 7 mm long. Lateral sepals ovate-lanceolate, oblique, sharply and acutely acuminate, three-nerved, about 6 mm long, 3 mm wide at the base. Dorsal sepal similar to the lateral ones. Petals linear-lanceolate, three-nerved, acute, about 5 mm long, 1.5 mm wide at the base. Labellum fleshy, constricted near the middle, the basal part saccate, about 7 mm long; the epichile deltoid-ovate, acute, about 5 mm long, 4.5 mm wide, the margins involute, minutely trilobed at the apex when expanded. Column short and broad, abruptly constricted in the middle with a fleshy

semiorbicular process in the basal half, narrowly bialate above, about 5 mm long, foot short but distinct. Pollinia clavate, 8.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 80833 Quisumbing*, August 25, 1930. The living plants were collected from the mountains between Siain and Atimonan, Tayabas Province, growing at medium altitudes on tree trunks. They thrive best in wooden baskets. The flowers are marguerite yellow [2] except the purple marginal wings of the column.

This species is manifestly allied to *Agrostophyllum malindangense* Ames, which it closely resembles in vegetative characters. It differs notably in its leaf sheaths not being inflated and expanded, particularly at the apical portion of the stem, its inflorescences not being densely capitate, and in having much larger flowers and differently shaped flower parts.

In the herbarium of Oakes Ames are two plants, with mature flowers, that must be referred to this species. The data are Nueva Vizcaya Province, Luzon, *J. de Veyra*, September 25, 1916, and the plants are said to be tufted and epiphytic.

Genus SPATHOGLOTTIS Blume

SPATHOGLOTTIS PLICATA Blume var. PARSONSII var. nov. Plates 1, 15, and 17, fig. 1.

Pseudobulbi ovoidei, 5 ad 7 cm longi, prope basim 3.5 ad 5 cm in diametro, valde rugosi. Folia lanceolata vel ellipticolanceolata, acuminata, 57 ad 70 cm longa, 9 ad 13.5 cm lata, in sicco conspicue nervosa. Pedunculus 50 ad 70 cm longus, erectus vel arcuatus, superne minute tomentosus. Flores 4.5 ad 5 cm in diametro. Labellum spici simile, circiter 2 cm longum, apicem retusum.

A variety resembling the species in habit. Pseudobulbs large, ovoid, 5 to 7 cm long, 3.5 to 5 cm in diameter at the widest portion, conspicuously rugose. Leaves lanceolate or ellipticlanceolate, acuminate, 57 to 70 cm long, 9 to 13.5 cm wide, the nerves very prominent, particularly when dried. Peduncles 50 to 70 cm high, rigid, erect, sometimes curved, minutely whitetomentose. Flowers 4.5 to 5 cm across, pale ochraceous-salmon or salmon-orange, flushed with mallow pink or pale rosolane purple. Sepals ovate-lanceolate, obtuse, 1.9 to 2 cm long, 9 to 10 mm wide, pubescent on the outer surface. Petals elliptic-ovate or oval, obtuse, 2 to 2.2 cm long, 1.4 to 1.5 cm wide. Pedicellate ovary tomentose, chrysolite green. Labellum about 2 cm long, three-lobed; lateral lobes oblong-obovate, broadly rounded,

[2] The color terms used are mostly from Ridgway's Color Standard and Color Nomenclature (1912).

oblique, the front lobe approaching that of *Spathoglottis plicata* in form, trilobulate, reniform and retuse at the apex with a long cuneate claw, straw-yellow or light salmon-orange, splashed at the middle with old rose or flame scarlet, the claw lemon chrome, the pair of side lobules at the base lemon chrome spotted with old rose, pubescent, white, triangular-acute, callus between the lobules lemon chrome or empire yellow and grenadine red, glabrous.

LUZON, Rizal Province, Pasay, Mrs. Geo. H. Fairchild's gardens, *Bur. Sci. 79663 Quisumbing*, August 22, 1930. The living plants were originally collected by Mr. Emilio Ermitaño, an orchid grower and dealer of Manila, from the grasslands below the Cañon Road, Baguio, Mountain Province, in February, 1929, and sold to Mr. W. Parsons, who has the plants now in his gardens at Geneva, Switzerland. The same variety was again collected by Mr. Ermitaño from about the same locality, in February, 1930, and sold to Mrs. Geo. H. Fairchild.

The new variety appears to be a natural hybrid between the light purple *Spathoglottis plicata* Blume and the yellow *Spathoglottis vanoverberghii* Ames. The floral structure and form resemble those of *S. plicata* Bl. The pubescence of the peduncles, pedicels, and outer surface of the sepals, however, is a feature of *S. vanoverberghii* Ames. The variety is readily distinguished from the two species by the color of the flowers. This variety is named in honor of Mr. W. Parsons, who, during his residence in Manila, courteously placed the facilities of his orchid collection at the disposal of the junior author. Mr. Parsons, at his home in Genthod, near Geneva, has now the best and largest collection of Philippine orchids in Switzerland.

Genus DENDROBIUM Swartz

DENDROBIUM BATANENSE sp. nov. Plates 1, 5, 16, and 17, fig. 2.

Caules aggregati, elongati, 9 ad 24 cm alti, supra graciles, vaginis foliorum obtecti. Pseudobulbi teretes, angulati; internodia plerumque 2 vel 3, 10 ad 21 mm longi. Folia disticha, ensiformia, lineari-lanceolata, valde complanata, acuta, 4 ad 6.5 cm longa, 3.5 ad 6 mm lata, 1.5 ad 3 cm inter se distantia. Flores albidi, circiter 2.5 cm longi, 2.5 cm in diametro. Sepala lateralia oblique oblongo-lanceolata, acuta vel obtusa, circiter 19 mm longa, 5 mm lata, 7-nervia, mentum obtusum, circiter 7 mm longum, formantia. Sepalum dorsale anguste oblongo-lanceolatum, subacutum, circiter 13 mm longum, 5 mm latum, 7-nervium. Petala anguste-oblanceolata vel elliptico-lanceolata, obtusa vel

acuta, circiter 12 mm longa, 4 mm lata, 3-nervia. Labellum a basi cuneata, trilobatum, circiter 16 mm longum; lobi laterales triangulares, obtusati vel acuti, trans apicem circiter 3 mm lati; lobus intermedius in circuitu suborbicularis, circiter 1 cm longus, margine fimbriato. Lineae 3 elevatulae per discum et ultra medium callus cristatus pubescens. Gynostemium sectionis. Capsula anguste ellipsoidea, circiter 3 cm longa, 6 mm in diametro.

The stems aggregated, elongate, 9 to 24 cm long, concealed by leaf sheaths. Pseudobulbs terete, angled; internodes usually 2 or 3, 10 to 21 mm long. Leaves distichous, linear-lanceolate, acute, flattened, 4 to 6.5 cm long, 3.5 to 6 mm wide. Flowers produced along the naked termination of the stems, white, very fragrant, about 2.5 cm long, 2.5 cm across. Lateral sepals obliquely oblong-lanceolate, acute or obtuse, about 19 mm long along the anterior margin, 5 mm wide, 7-nerved, forming an obtuse mentum about 7 mm long. Dorsal sepal narrowly oblong-lanceolate, subacute, about 13 mm long, 5 mm wide, 7-nerved. Petals narrowly oblanceolate or elliptic-lanceolate, obtuse or acute, about 12 mm long, 4 mm wide, 3-nerved. Labellum cuneate at the base, about 16 mm long, trilobed; lateral lobes triangular, obtuse or acute, about 3 mm wide across the apex, lined within with purple; the middle lobe suborbicular in outline, about 1 cm long, the margins conspicuously fringed like the labellum of *Dendrobium polytrichum* Ames. The throat deep chrome at the base, the pubescent disc with three elevated lines. Gynostemium white, about 10 mm long, tridentate at the apex. Capsule narrowly ellipsoid, about 3 cm long, 6 mm in diameter, subterete, one side somewhat flattened, with three distinct longitudinal ribs.

BATAN ISLAND, Batanes Province, Mount Iraya, *Bur. Sci. 79934 Ramos*, April 29, 1930, growing on tree trunks, altitude about 700 meters.

Living plants brought to Manila by Mr. M. Ramos, botanical collector, Bureau of Science, are now growing in the Bureau of Science orchid house and flower throughout the year. The plants when first brought to Manila flowered twice in September, 1930, and have flowered monthly since, and sometimes even twice a month.

In general habit this species has several close allies, particularly *Dendrobium polytrichum* Ames and *Dendrobium carinatum* (L.) Willd., but it differs from both species in details of the lip.

DENDROBIUM FAIRCHILDAE sp. nov. Plates 2, 7, 18, and 19.

Caules aggregati, elongati, basi attenuati, folia lanceolata, acuta, 13 ad 17 cm longa, 1.5 ad 2.6 cm lata, gerentes. Racemi brevissimi, 7-vel 8-flori, e caulibus defoliatis orientes. Flores circiter 5 cm longi, 4 cm lati. Sepala lateralia obliquissime triangulari-ovata, in apice cucullata, 1.8 ad 2.4 cm longa, secundum columnae pedem 2.5 ad 3 cm lata; mentum valde elongatum, superne abrupte reflexum. Sepalum dorsale ovato-lanceolatum, obtusum vel subacutum, 1.8 ad 2.6 cm longum, 9 ad 12.5 mm latum. Petala oblongo-elliptica, obliqua, in apice rotundata, 1.8 ad 2.4 cm longa. Labellum perbreviter, 3.3 ad 4 cm longum, obscurissime trilobum; lobi laterales breves, erecti, late rotundati; lobus intermedius productus late ovatus, abrupte acutus, reflexus, discus glaber.

Stems terete, aggregated, elongate, 66 to 95 cm tall, leafy, 7 to 10 mm in diameter at the middle, 3 to 5 mm across at the base; the nodes 1.5 to 4.5 cm distant. Leaves distichous, deciduous, lanceolate, acute, 13 to 17 cm long, 1.5 to 2.6 cm wide, 9-nerved, membranaceous, greenish, articulated to tubular sheaths. Leaf sheaths up to 4.5 cm long, membranaceous, deciduous on the lower part of the plant. Flowers 7 or 8, in very short lateral racemes, about 5 cm long, 4 cm across, with a strongly curved spur. Peduncles sheathed, about 5 mm long below the flowers, the rachis about 1.5 cm long, glabrous. Bracts lanceolate, purplish, up to 5 mm long. Pedicellate ovary 3.5 to 4 cm long, pale flesh color, pedicel slender. Lateral sepals very obliquely triangular-ovate, obtuse or subacute, somewhat cucullate at the tip, 1.8 to 2.4 cm long, about 2.5 to 3 cm wide along the column-foot. Dorsal sepal cucullate, reflexed, ovate-lanceolate, obtuse or subacute, 1.8 to 2.6 cm long, 9 to 12.5 mm wide, 7-nerved. Petals oblong-elliptic, oblique, rounded at the tip, 1.8 to 2.4 cm long, 1 to 1.2 cm wide, 7-nerved, margin entire. Labellum very shortly unguiculate, 3.3 to 4 cm long, cuneate-obovate, narrowed to the base, sharply bent at the base to conform to the curved spur formed by the mentum of the lateral sepals, very obscurely 3-lobed; the lateral lobes erect, broadly rounded; the front lobe produced, broadly ovate, abruptly acute, about 1.8 cm wide at the broadest portion, reflexed; the disc glabrous with a small hippocrepiform callus at the base. Column white, very short and stout, about 5 mm long, extended in an elongate foot.

The flowers are odorless, white with the apices of the petals and the labellum flushed with mallow pink or phlox purple; the

spur white with shades of mallow pink or phlox purple, the anther cap marguerite yellow and the base of the labellum primuline yellow.

LUZON, Rizal Province, Pasay, Mrs. Geo. H. Fairchild's gardens, *Bur. Sci. 80820 Quisumbing*, October 2, 1930. The plants were originally collected near Kilometer 42, Mountain Road to Bontoc, Mountain Province, growing on exposed rocks and they are now under cultivation in Mrs. Fairchild's gardens.

This species belongs in the group with *Dendrobium ramosii* Ames, *D. o'brienianum* Kränzl., and *D. epidendropsis* Kränzl. It is especially close to the first, but differs radically in being a much larger plant with very much larger flowers with dissimilar floral details.

The species is dedicated to Mrs. Geo. H. Fairchild, an orchid enthusiast with large collections in her gardens at Pasay, near Manila, and in Baguio. Through her untiring interest in Philippine orchids, she has succeeded in cultivating many of the beautiful, rare, and wild orchids of these Islands.

DENDROBIUM JUNCEUM Lindl. Plates 2, 8, 20, and 21.

Dendrobium junceum LINDL. in Bot. Reg. 28 (1842) Misc. p. 9, No. 11; REICHB. f. in Walp. Ann. 6 (1861) 281, Gard. Chron. (1873) 361; KRÄNZL. in Engl. Pflanzenreich IV. 50. II B. 21 (1910) 240.

Caules aggregati, supra parce ramosi, usque ad 115 cm longi; pars basalis 5 ad 15 cm longa, fusiformis, incrassata, sulcata, 1.5 ad 2.5 cm crassa; cum 3 internodiis 1.5 ad 3.5 cm longis; pars superior gracilis, teres, 2 ad 3 mm in diametro. Folia subteretia, sulcata, filiformia, subulata, 8 ad 16 cm longa, 1.5 ad 2.5 mm in diametro. Flores fugaces, viridi-flavicum, labello purpureo-striato, in apice caulium et in axillis foliorum spueriorum singuli orientes, 3.5 ad 4 cm longi, 3 ad 4 cm lati; bracteae breves hyalinae; ovarium cum pedicello 1.6 ad 1.8 cm longum. Sepala lateralia latissime triangularia, obliquissima, acuta, basi anteriore dilatata, mentum obtusum formantia, 1.8 ad 2 cm longum. Sepalum dorsale triangulari-lanceolatum vel ovato-lanceolatum, acutum, 1.5 ad 1.8 cm longum, 0.9 cm latum, 5-vel 7-nervium. Petala ovato-lanceolata, acuta, circiter 1.4 cm longa, 0.6 cm lata, 3- ad 7-nervia. Labellum prope apicem trilobum, e basi cuneata, obovatum, 2.3 ad 2.5 cm longum; lobi laterales late triangulares; lobus intermedius major quam laterales, semiorbicularis, margine crispatus et minute crenulatus, papillosus. Discus per partem basalem leviter tricarinatus, carinae antice in faeciam singulam carnosam productum. Gynos-

temium crassum, perbreve, superne tridentatum, in pedem elongatum extensum.

Stems rather tall, branching sparingly near the top, up to 115 cm long, pseudobulbous at base; lower part 5 to 15 cm long, fusiform, enlarged at the middle and tapering at both ends, conspicously ridged, 1.5 to 2.5 cm in diameter with 3 internodes 1.5 to 3.5 cm long; upper part slender, terete, 2 to 3 mm in diameter, greenish olive or reddish brown. Leaves subterete, channelled, filiform, subulate, 8 to 16 cm long, 1.5 to 2.5 mm in diameter, dark green. Flowers produced singly from tufts of bracts along the naked termination of the stems or from the axils of upper leaves, 3.5 to 4 cm long, 3 to 4 cm across. The bracts small, hyaline. Pedicellate ovary 1.6 to 1.8 cm long. Lateral sepals very broadly triangular, very oblique, as long as the dorsal sepal, forming with the column-foot a spur that is stout, rather recurved, obtuse, 1.8 to 2 cm long. Dorsal sepal triangular-lanceolate or ovate-lanceolate, acute, 1.5 to 1.8 cm long, 0.9 cm wide, 5- to 7-nerved. Petals ovate-lanceolate acute, about 1.4 cm long, 0.6 cm wide, 3- to 7-nerved. Labellum trilobed near the apex, cuneate at the base, obovate, 2.3 to 2.5 cm long; lateral lobes broadly triangular; the middle lobe larger than the lateral lobes, semiorbicular, notched at the apex, crisped, the margins minutely crenulate, papillose. Disc through the basal part lightly tricarinate, the keels produced in front into a single fleshy band. Column very short and stout with three teeth at the apex, extended into an elongated foot.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 79065 Quisumbing*, May 24, 1930, the living plants being originally collected at Atimonan, Tayabas Province.

The flowers open one at a time on the nodes along the naked termination of the stems or in the axils of apical leaves and are very fragrant, the odor approaching that of *Dendrobium crumenatum* Sw. In habit the flowers differ from those of *D. crumenatum* Sw. in that they remain fresh on the plant for several days. The sepals, petals, spur, and pedicellate ovary are chartreuse yellow with some cream color at the apices of the petals and sepals. The lateral lobes of the labellum including the cuneate base are white, the reticulations are dark rhodamine purple or true purple, the middle lobe of the labellum and the disc are chartreuse yellow. The plants first flowered in the Bureau of Science orchid house June 1, 1929, and again May 24, 1930.

Dendrobium junceum Lindl. was supposed in the original description to have come from Singapore, but Ridley [3] doubts this origin and says that "what I take to be the plant intended I received from Manila, sent by Sr. Vidal." A record of the type of *D. junceum* together with the sketch of the lip in the herbarium of Oakes Ames shows an identical species beyond question. The flowers of the plants from Tayabas are larger than those of the type specimen in Lindley's herbarium, but similar to them in all salient points. The labellum in our material is not so prominently 3-lobed as represented in Lindley's sketch, yet the central carina and the surface of the middle lobe exhibit no marked difference from the type material as interpreted by Lindley. In habit *D. polytrichum* Ames resembles this species closely.

DENDROBIUM MODESTUM Reichb. f. Plates 1, 6, and 22.

Dendrobium modestum REICHB. f. in Bonpl. 3 (1855) 222, in Walp. Ann. 6 (1861) 281; NAVES, Novis. App. (1882) 234; KRÄNZL. in Engl. Pflanzenreich IV. 50. II. B. 21 (1910) 220; AMES, Orch. 5 (1915) 128, in Merr. Enum. Philip. Fl. Pl. 1 (1924) 352.

Species *D. aciculari* Lindl. et *D. philippinensi* Ames affinis. Planta epiphytica 30 ad 55 cm alta. Caules purpurei; pars basalis per 7 ad 13.5 cm longa, fusiformi-incrassata, 8-angulata, 5 ad 7 mm in diametro; pars superior teres, gracilis, 1.5 ad 2 mm crassa; internodia prope basim usque ad 4.5 cm longa. Foliorum vaginae cylindriceae, internodiis aequilongae. Folia teretia, acicularia vel subulata, acuta, adscendentia, glabra, carnosula, rigidiuscula, 5.5 ad 10.5 cm longa, 1.75 ad 2.5 mm in diametro, quam internodia plerumque longiora. Flores pauci, pallide purpurei, singuli, versus apicem caulis. Bracteae quam ovarium pedicellatum breviores. Pedicellum cum ovario circiter 7 mm longum, gracile. Sepala lateralia latissime et obliquissime triangularia, acuta, circiter 7 mm longa, 7 mm lata secundum columnae pedem, 3- ad 5-nervia, mentum obtusum formantia. Sepalum dorsale triangulari-lanceolatum, acutum, circiter 6.5 mm longum, in basi 3 mm latum, 5-nervium. Petala anguste elliptica, obtusa, circiter 6.5 mm longa, 1.75 mm lata, 1-nervia. Labellum e basi sensim cuneata dilatatum, prope apicem leviter trilobatum, circiter 12 mm longum; lobi laterales antice subrotundati, denticulati, circiter 1.5 mm lati; lobus intermedius subquadratus, antice subrotundatus, denticulatus, in apice api-

[3] Journ. Linn. Soc. 32 (1896) 250.

culatus. Discus lineis 3, nervisque purpureis, parallelis percursus. Gynostemium perbreve, in pedem elongatum extensum.

An epiphyte 30 to 55 cm high. The stems flushed with purple; the lower part pseudobulbous, angled, much thickened, consisting of three internodes which are up to 4.5 cm long and 5 to 7 mm in diameter; the upper part terete, 1.5 to 2 mm in diameter. The leaf sheaths cylindrical, as long as the internodes. Leaves terete, acicular or subulate, acute, 5.5 to 10.5 cm long, 1.75 to 2.5 mm in diameter, ascending, glabrous, rather fleshy and rigid, flushed with brownish purple. Flowers odorless, few, pale purple, appearing singly at the extremities of the stems. The bracts minute and very much shorter than the pedicellate ovary. Pedicellate ovary slender, about 7 mm long. Lateral sepals very broadly and obliquely triangular, acute, about 7 mm long, 7 mm wide along the column-foot, 3- to 5-nerved, forming an obtuse spur. Dorsal sepal triangular-lanceolate, acute, about 6.5 mm long, 3 mm wide at the base, 5-nerved. Petals narrowly elliptic, obtuse, about 6.5 mm long, 1.75 mm wide, 1-nerved. Labellum gradually cuneate at the base, dilated somewhat at the apex, lightly trilobed beyond the middle, about 12 mm long; lateral lobes subrounded, denticulate, about 1.5 mm wide across the apex; middle lobe subquadrate, denticulate, the apex very broadly rounded and apiculate, about 2.5 mm long, 3.5 mm wide. Disc traversed by three distinct parallel lines, which are conspicuously purple. The column very short, tridentate at the apex, extended into an elongate foot.

CORON ISLAND, Palawan Province, *Bur. Sci. 78800 W. H. Brown*, December 24, 1929. Living plants were collected by Dr. William H. Brown, director of the Bureau of Science, Manila, during a trip to Coron Island, while en route to Culion Leper Colony, situated on Culion Island, Palawan Province. These plants were found growing as an epiphyte on small trees on cliffs along the shore, and are now being cultivated in the Bureau of Science orchid house.

Dendrobium modestum Reichb. f. has heretofore escaped all modern collectors. However, a record in the herbarium of Oakes Ames shows a sketch from the herbarium of Reichenbach that represents unmistakably a species similar to the one from Coron Island. A minor discrepancy appears in the short, scarcely uncinate lateral teeth of the column.

Genus BULBOPHYLLUM Thouars

BULBOPHYLLUM CLEISTOGAMUM Ridl. Plates 3, 9, and 23.

Bulbophyllum cleistogamum RIDL. in Journ. Linn. Soc. 31 (1896) 277, Fl. Malay Penin. 4 (1924) 69; CARR in Gard. Bull. Straits Settlements 5 (1930) 139, *t. 2, f. 5.*

"Rhizoma pseudobulbis pluribus approximatis tectum; pseudobulbi *conici* sulcati, 3/4 pollices longi, laete virentes. Folium oblongum petiolatum subacutum, canaliculâ distinctâ, carinâ dorsali paullo elevatâ, 4–6 pollices longum, 3/4–1 pollicem latum, petiolo profunde canaliculato, 1/2 poll. longo. Scapi plures rigiduli teretes, ad 12 pollices longi, virides, bracteis siccis subacutis, 1/2-pollicaribus arcte amplectentibus. Racemus breviusculus complanatus, bracteis ovatis acutis, mucronatis, 1/4-pollicaribus amplectentibus. Flores mediocres *cleistogami,* saepissime clausi, raro paullo expansi. Sepala *lanceolata acuminata* acuta, pallide straminea, 3/4 poll. longa, lateralia basi dilatata intus rubescentia. Petala *minuta quadrata* subdenticulata, mucrone subulato longiusculo, viridia. Labellum *elongatum curvum acutum,* basi latâ, lobis duobus lateralibus parvis falcatis, carinis duabus approximatis a basi usque ad geniculatum, basi kermesinum, apice stramineum. Columna brevis crassa viridis, margine clinandrii denticulato. Stelidia *subulata erecta,* pede kermesino haud producto. Anthera ovata. Rostellum *nullum.*" Ridley, l. c.

Rhizomes creeping, branched, 3 to 5 mm in diameter, clothed with dry tubular sheaths, which later become fibrous; internodes 3 to 5 mm long. Pseudobulbs 1-leaved, cylindric-conic, usually curved, 2 to 3.5 cm long, 1 to 1.5 cm in diameter at the base, 0.7 to 2.5 cm distant, wrinkled and longitudinally grooved. Leaves dark green, more or less erect, oblong, oblong-lanceolate or oblong-elliptic, acute, 14.5 to 17.5 cm long, 3.5 to 4.5 cm wide; petioles grooved, 1 to 2 cm long. Inflorescences arising from the base of the pseudobulbs, more or less erect; the peduncles greatly elongated, terete, green suffused with dark purple, 50 to 61 cm long, 1.5 to 2 mm in diameter, clothed at every node with a tubular sheath. Bracts triangular, acute, 7 to 9 mm long, strongly keeled on the back. Flowers odorless, appearing singly at intervals of several weeks, widely expanded, 4 to 4.5 cm across; pedicellate ovary 1.5 to 2 cm long. Sepals spreading, chartreuse yellow tinted with pale vinaceous; the veins, reticulations, and margins dull dark purple. Lateral sepals falcately

triangular-lanceolate, acutely acuminate, 2 to 2.5 cm long, 7 to 8 mm wide, dorsally carinate, 9-nerved. Dorsal sepal erect, oblong-lanceolate, acutely acuminate, about the same size as the sepals, 7- to 9-nerved. Petals very small, 1-nerved, ovate-subquadrate, about 2 mm long without the cusp, about 3 mm wide near the base, the upper half pectinate, the middle nerve prolonged into a long cusp about 1.7 mm long, pale chalcedony yellow, with three patches of Hay's maroon near the base. Labellum reflexed near the base, maroon, mobile, attached by a minute claw to the foot of the column, fleshy, entire, tongue-shaped, about 2 cm long, the very tip acuminate; the basal portion dilated into a pair of erect auricles terminated on each side by an uncinate lobule, in the groove between the auricles runs a pair of approximate converging keels, the upper portion keeled, convex, tumid-rugulose. Column very short, stout, straw yellow, terminating in a pair of spreading, subquadrate, apically bilobed arms of which the posterior lobe is short-triangular and the anterior lobe is subulate and about 1.5 mm long; clinandrium excavated, transversely elliptic; rostellum wanting, the foot at right angles to the column, about 7 mm long; anther semiorbicular, about 1.5 mm long, naphthalene yellow with a median maroon spot.

LUZON, Tayabas Province, Atimonan, *Bur. Sci. 80829 Quisumbing*, April 6, 1930. The specimens were collected from the Quezon National Park, across the road from Gate No. 2 cottage, growing on a dead, standing tree trunk.

This species, which was originally collected from Riouw (Rhio), Borneo, and later reported also from the Malay Peninsula (Perak, Waterloo and Tahan), is new to the Philippines.

Bulbophyllum cleistogamum Ridl. is distinct from any Philippine *Bulbophyllum* by its greatly elongated, slender peduncles and the structure of its flowers, particularly of the labellum, petals, and sepals. The peduncles, indeed, are much more elongated than those previously described.

As Carr [4] points out the designation *cleistogamum* is rather a misnomer, for the flowers are usually widely expanded.

BULBOPHYLLUM MAQUILINGENSE sp. nov. Plates 3 and 10.

Herba epiphytica. Radices fibratae, glabrae. Rhizoma repens. Pseudobulbi conferti, suberecti, ovoidei vel oblongo-ovoidei, 9 ad 16 mm longi, 6 ad 10 mm in diametro, monophylli. Folium ellipticum vel elliptico-oblongum, obtusum, subcoriaceum,

[4] Gard. Bull. Straits Settlements 5 (1930) 139.

1.5 ad 4.5 cm longum, 1 ad 1.5 cm latum. Inflorescentiae erectae, fasciculatae, 1-florae; pedunculus filiformis, 3 ad 5 cm longus; bractea minuta, infundibuliformis, circiter 1.5 mm longa. Pedicellus cum ovario circiter 7 mm longus, gracilis. Sepala lateralia oblique oblonga, acuta, circiter 9 mm longa, 3.5 mm lata, 3-nervia. Sepalum dorsale valde cucullatum, ellipticum, subacutum, 9.5 ad 10 mm longum, 5 ad 6 mm latum, 3-nervium. Petala oblongo-elliptica, acuta vel obtusa, quam sepalum dorsale minora, circiter 7 mm longa, 3 mm lata, 1-nervia. Labellum mobile, lingulatum, carnosum, obtusum, in basi utrinque auriculato-lobatum, vix 6 mm longum, in medio constrictum, parte anteriore spathulata vix 3.5 mm longa; lobi laterales parvi, erecti, vix 1 mm longi, glabri. Gynostemium breve, stelidiis subulatis; anthera subglobosa.

Rhizomes creeping, very slender. Roots fibrous. Pseudobulbs crowded, suberect, ovoid or oblong-ovoid, 9 to 16 mm long, 6 to 10 mm in diameter, smooth or grooved, 1-leaved. Leaves erect, often slightly recurved towards the apex, elliptic or elliptic-oblong, obtuse, 1.5 to 4.5 cm long, 1 to 1.5 cm wide, subcoriaceous, green, sharply sulcate through the middle of the upper surface, with conspicuous median keel beneath; petioles very short, up to 3 mm long. Inflorescences 3 to 8 from the base of each pseudobulb, fascicled, erect, 1-flowered; the peduncles filiform, 3 to 5 cm long. Bracts funnel-shaped, about 1.5 mm long. Pedicellate ovary very slender, about 7 mm long. The sepals cameo pink, barred and mottled with Schoenfeld's purple. Lateral sepals obliquely oblong, acute, about 9 mm long, 3.5 mm wide, 3-nerved, the nerves elevated on the back, inner margins ciliolate and narrowly involute. Dorsal sepal strongly cucullate, elliptic, subacute, 9.5 to 10 mm long, 5 to 6 mm wide, 3-nerved, the nerves elevated on the back. Petals smaller than the sepals, oblong-elliptic, about 7 mm long, 3 mm wide, 1-nerved, olive green barred and mottled with dull dusky purple. Labellum tongue-shaped, blackish red-purple, adnate by a thin claw to the apex of the column-foot, mobile, fleshy, subentire, about 6 mm long, constricted in the middle, the spatulate apex about 3.5 mm long; lateral lobes on each side of the base small, auriculate, erect, about 1 mm long. Column very minute, stelidia subulate; anther subglobose.

LUZON, Laguna Province, Mount Maquiling, *Bur. Sci. 80830 Quisumbing*, April 4, 1930. A glabrous epiphyte, growing on tree trunks, above the second camp.

In the herbarium of the senior author is a sheet of three unnamed plants with a single agglutinated flower the parts of which show that the plants are referable to *Bulbophyllum maquilingense.* The leaves are apparently narrower than those of the type, the smallest being linear-oblong, 2.7 cm long and 4 mm wide. The data of this collection are: LUZON, Tayabas Province, Mount Banahao, *A. D. E. Elmer* (?) *3797*, May, 1906. "On undershrubs in the forests at 800 meters; flowers comparatively large, pink, spotted, rare."

Bulbophyllum maquilingense is very similar vegetatively to *B. fenixii* Ames, but it appears to be distinct from all Philippine members of the genus by the strongly cucullate dorsal sepal and the unusual color markings of the flower.

Genus RENANTHERA Loureiro

RENANTHERA STORIEI Reichb. f. var. **PHILIPPINENSIS** var. nov. Plates 3, 7, and 24.

A specie haec planta parvitate communi, labelli lobis lateralibus angustioribus truncatis et lobo intermedio latiore differt.

Stems erect, terete, dark brown, smaller than in the species, up to 80 cm high, 6 to 7 mm in diameter. The roots greatly elongated, 2 to 5 mm in diameter. Leaves distichous, much smaller than in the species, greenish or greenish yellow (very much paler than in the species, where it is dark green), coriaceous, oblong, unequally bilobed at the rounded apex, 4.5 to 9.5 cm long, 1.5 to 3.4 cm wide. Peduncles 14 to 15 cm long, terete; the bracts tubular, remote, 4 to 5 mm long. Panicles many-flowered (up to 45 flowers). Flowers slightly fragrant, scarlet red, except the bases of the lateral lobes of the labellum which are cream-colored and the base of the middle lobe and the throat of the labellum which are orange, 1.8 to 2 cm wide, 2.5 to 3.2 cm long. Lateral sepals oblong-oblanceolate or oblanceolate, somewhat unguiculate, broadly obtuse or rounded, 1.3 to 2 cm long, 6 to 7 mm wide across the broadest portion, 3- to 5-nerved. Dorsal sepal narrowly oblanceolate, subacute, 1.1 to 1.4 cm long, 3 to 3.5 mm wide, 3- to 5-nerved. Petals narrower and shorter than the sepals, narrowly oblong-oblanceolate or narrowly linear-oblanceolate, broadly obtuse or rounded, 0.9 to 1.3 cm long, 2 to 2.5 mm wide, 3- to 5-nerved. Labellum fleshy, 5 to 6.5 mm long, deeply saccate-spurred at the base; lateral lobes subquadrate, broadly truncate, 1.25 to 1.5 mm long; the middle lobe broadly ovate, subacute, 2.25 to 2.5 mm long, about 2 mm wide; the spur rounded, about 2 mm long. Column

minute, about 2.5 mm long. Anther broadly ovoid, about 1.75 mm across. Pollinia suborbicular.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 78826 Quisumbing,* December 28, 1929. The living plants were collected on trees in mangrove swamps in Aloneros, Tayabas Province, and flowered from October to March. The plants succeed well when nailed on adobe fences, using staples to hold the stems.

This dwarf variety of *Renanthera storiei* differs radically from the species in its small stature, small leaves and flowers, and the narrower broadly truncated lateral lobes of the labellum.

Although the flowers in the variety here proposed are smaller than in the type, it is noteworthy that intergrading forms may appear. In the herbarium of Oakes Ames there is a specimen, *A. Loher 6000,* collected in Rizal Province, with flowers that are equal in size to the largest flowers of var. *philippinensis* with leaves up to 1.5 dm long by 3.8 cm wide. This specimen is clearly referable to var. *philippinensis.*

Genus VANDA Jones

VANDA MERRILLII sp. nov. Plates 3, 11, 25, and 26.

Planta erecta, usque ad 95 cm alta. Folia disticha, parte inferiore imbricantia, rigida, recurvata, lineari-oblonga, oblique bilobata, 25 ad 32 cm longa, 2.8 ad 3.5 cm lata. Inflorescentiae laxae, 7- ad 11-florae, pedunculo incluso circiter 25 cm longae. Flores odoratissimi, 3 ad 3.5 cm in diametro. Sepala lateralia obovata, valde obtusa vel rotundata vel retusa, circiter 1.8 cm longa, 1.3 ad 1.5 cm lata, carnosa, margine valde undulato. Sepalum dorsale simile. Petala subsimilia, leviter unguiculata. Labellum trilobatum, carnosum, in basi in calcar parvum productum; lobi laterales erecti, subquadrati, circiter 3.5 mm longi; lobus intermedius multo major, panduratus, glaber, apice retusus, supra convexus, in basi utrinque auriculatus, circiter 12.5 mm longus, prope basim 12.5 mm latus. Columna abbreviata, crassissima. Pollinia 4, dissimilia, oblique ellipsoidea. Capsula oblongo-obovoidea, profunde carinata, circiter 10 cm longa, 2.5 cm in diametro.

Plant erect, up to 95 cm high. Stems terete. Leaves distichous, linear-oblong, closely imbricated at the base, recurved, rigid, 25 to 32 cm long, 2.8 to 3.5 cm wide, unequally bilobed at the apex, light green, much paler than those of *Vanda luzonica,* which are usually dark green. Racemes 1 to 3 in each plant,

spreading, loosely 7- to 11-flowered, about 25 cm long including the peduncles; the peduncles massicot yellow, rather stout. Flowers very fragrant, fleshy, 3 to 3.5 cm across, nearly as long. Pedicellate ovary massicot yellow, twisted, 3.5 to 6.5 cm long. Bracts broadly ovate, obtuse, up to 5 mm long. Sepals obovate, narrowed to the base, broadly obtuse, rounded or retuse at the apex, strongly undulate, about 1.8 cm long, 1.3 to 1.5 cm wide at the broadest portion, the lateral sepals slightly wider. Petals similar to the sepals in form, lightly clawed, slightly smaller, about 1.8 cm long, 1 to 1.1 cm wide. Labellum trilobed, fleshy, shortly spurred; lateral lobes erect, subquadrate, incurved, about 3.5 mm long; middle lobe much larger, pandurate, glabrous, retuse at the apex, convex above, auriculate on each side, about 12.5 mm long, 12.5 mm wide, with 4 more or less obscure raised nerves above, at the throat of the spur with two raised papillæ; spur small, compressed, about 4 mm long. Column very short and stout, much swollen laterally at the base. Pollinia 4, unequal, obliquely ellipsoid. Capsules oblong-obovoid, deeply ridged, about 10 cm long, 2.5 cm in diameter.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 80832 Quisumbing*, August 25, 1930. The living plants were originally collected from the forests of Cabuyao, Atimonan, Tayabas Province, growing on trees, similar in habit to *Vanda luzonica* Loher.

The sepals and petals pinard yellow washed and stained half way to the apex and at the base with carmine or nopal red, striations of the same color in the middle. The lateral lobes of the labellum white with purple dots; middle lobe reed yellow, washed with dragon's blood red, the four raised nerves purple, the auricles dotted with pomegranate purple. Column and anther white with purple dots.

The native collectors, because of the habit of the plant, erroneously called it "*Vanda luzonica.*"

This magnificent species belongs in the group with *Vanda tricolor* Lindl., but differing in the color of the flowers and in the shape of the labellum, etc. Its closest Philippine relative is *Vanda luzonica* Loher from which it can be distinguished not only by the general habit, but also by the form, size, and color of the flowers. *Vanda truncata* J. J. Sm., from Dutch New Guinea, is apparently a closely allied species, which differs chiefly in the shorter, few-flowered racemes and dissimilar floral markings.

Genus ROBIQUETIA Gaudichaud

ROBIQUETIA PANTHERINA (Kränzl.) Ames. Plates 2, 11, and 27.

Robiquetia pantherina (Kränzl.) AMES, Sched. Orch. 6 (1923) 95, in Merr. Enum. Philip. Fl. Pl. 1 (1925) 435.
Cleisostoma spatulatum BLUME apud Naves Novis. App. (1882) 238.
Saccolabium densiflorum LINDL. in Bot. Reg. 24 (1838) Misc. 56, quoad Philip., non Lindl. in Wall. Cat.; REICHB. f. in Walp. Ann. 6 (1864) 885, quoad Philip.; NAVES, Novis. App. (1882) 241.
Robiquetia spathulata AMES, Orch. 5 (1915) 237, non J. J. Sm.
Saccolabium pantherinum KRÄNZL. in Fedde Repert. 17 (1921) 391.

Stem pendulous, stout, somewhat thickened and compressed, about 32 cm long, 5 to 10 mm in diameter. Leaves coriaceous, oblong, slightly contracted at the sheathing base, unequally and broadly bilobed at the rounded apex, 15 to 18.5 cm long, 4.5 to 5 cm wide. Racemes opposite the leaf bases, elongate, densely flowered, pendulous, simple or one-branched, about 30 cm long including the peduncle; the peduncle stout, about 5.5 cm long, 4 mm in diameter. Flowers odorless, fleshy, 9 to 10 mm across; floral bracts lanceolate, acute, 3 to 7 mm long. Pedicellate ovary puberulent, 6 to 8 mm long. Lateral sepals spreading, broadly and obliquely elliptic-obovate, slightly cucullate or almost flattened, rounded, about 5 mm long, 3 mm wide, the tip slightly bent forward. Dorsal sepal broadly elliptic or oval, rounded, about 4 mm long, 3 mm wide, the tip bent forward, cucullate. Petals spreading, more or less flattened, obovate or obovate-oblong, obtuse, about 3.5 mm long, 2.5 mm wide. Labellum adnate to the column, consisting of an infundibuliform strongly incurved spur which is laterally dilated, and minutely 4-lobulate at the apex, 3-lobed at the mouth; lateral lobes narrow, erect, furnished with a fleshy carinate callus inside near the irregular margins; middle lobe triangular, subacute, fleshy, inflexed, about 3 mm long. There is a well-developed scale ascending obliquely from the anterior wall of the sac and an inconspicuous forcipate scale on the posterior wall. Column stout, very short. Anther acuminate, depressed, long-beaked. Pollinia 2, globose.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 80825 Quisumbing*, September 13, 1930. The living plants were collected from Rizal Province, in the forests, with no definite locality.

The sepals and petals are covered with conspicuous maculations, the background amber yellow mottled and banded with brownish purple. The lateral lobes of the labellum amber yellow

with a circle of brownish purple, the middle lobe amber yellow with two patches of eugenia red at the base, the tip spotted with eugenia red. The spur marguerite yellow.

This species was originally known from the collection of Cuming.[5] It was subsequently discovered by the late C. A. Wenzel, *No. 180*, July 15, 1913, from Dagami, Leyte, in forests 60 meters above sea level. Kränzlin's type of *Saccolabium pantherinum* was collected by Loher, s. n.

As pointed out by Ames,[6] *Robiquetia pantherina* is limited to the Philippine Islands, where it is rare. It "is closely related to *R. spathulata* J. J. Sm.," from which it differs "in having the scale on the anterior wall of the sac obliquely ascending . . . Other differences are found in the contour of the labellum and in the somewhat differently shaped lateral lobes."

Robiquetia pantherina may be recognized among all known Philippine species by the conspicuous maculations on the petals and sepals and by the peculiar form of the labellum, particularly the structure of the spur.

Genus STAUROPSIS Reichenbach f.

STAUROPSIS FASCIATA Benth. Plates 2, 12, 28, and 29.

Stauropsis fasciata BENTH., Gen. Pl. 3 (1883) 572; KRÄNZL. in Xen. Orch. 3 (1894) 132, *t. 275, I 1–7;* VEITCH, Man. Orch. Pl. 2 (1891) Subtribe Sarcantheae 2; Sanders' Orch. Guide (1927) 421.

Trichoglottis fasciata REICHB. f. in Gard. Chron. (1872) 669, L'Orchidophile (1885) 283, fig.; WILLIAMS, Orch. Album 5 (1886) *t. 208*, Orch. Grower's Manual ed. 7 (1894) 732, f.

Staurochilus fasciatus RIDL. in Journ. Linn. Soc. 32 (1896) 351; SCHLECHTER, Die Orchideen (1927) 570.

Vandopsis leytensis AMES, Orch. 5 (1915) 222.

"*Trichoglottis fasciata*, n. sp.

"Bene caulescens, foliis cuneato ligulatis obtuse bilobis abbreviatis (1″ lat. 4″ long.); spicis paucifloris, grandifloris, ovariis pedicellatis trigonis; sepalis petalisque cuneato oblongo acutis, sepalis lateralibus falcatis; labello basi cum columna connato; auriculis baseos dolabratis; lamina antica trifida, laciniis lateralibus triangulis patulis, lacinia media carinaeformi antice oblique obtusata; lineis velutinis ternis in fundos columna utrinque juxta antheram unifalcata; ligula baseos ligulata bidentata velutina nunc erosulo dentata, semper tenuissima." Reichb. f., in Gard. Chron. (1872) 699.

[5] Bot. Reg. 24 (1838) Misc. 56.
[6] Sched. Orch. 6 (1923) 95.

Plant erect or curved, 50 cm or more long. Roots stout, greatly elongated, piercing the leaf sheaths of the lower part of the stem, up to 45 cm long. Stems rigid, about 1 cm in diameter, terete, somewhat flattened toward the apex, concealed by tubular leaf sheaths; internodes 2 to 3.5 cm apart. Leaves distichous, oblong, 9 to 11.5 cm long, 3 to 3.7 cm wide, leathery, thick, flat, spreading, pale yellowish green, equally or unequally bilobed at the broad apex. Racemes rather stout, ascending, 3- or 4-flowered, about 15 cm long including the peduncle, which is 7 cm in length. Flowers large, about 4 cm across, very lax, fleshy, fragrant, lasting for a month or longer. Floral bracts deeply clasping or amplexicaul, triangular-ovate, apiculate, dorsally carinate, 7 to 10 mm long. Pedicellate ovary trigonous, marguerite yellow, about 2 cm long. Lateral sepals elliptic, 2.5 to 2.8 cm long, 1.1 to 1.3 cm wide at the widest portion, subacute, at the very tip with a dorsal horn, which is 4 mm long. Dorsal sepal similar. Petals oblanceolate, 2.3 to 2.5 cm long, 0.8 to 0.9 cm wide, subacute, with a horn at the very tip. Labellum about 1.9 cm long, fleshy, 5-lobed, base deeply concave; the basal lobes broadly rounded, auriculate, bluntly angled in front, erect, about 4 mm long, deeply connate with the sides of the column; middle lobe 3-lobed with lobes at right angles; side lobes triangular-lanceolate, 7 to 8 mm long, subacute, erect-spreading; terminal lobe linear-triangular, strongly compressed laterally and keel-like (when viewed from the side, highest beyond the middle), obtuse, about 9 mm long, 4 mm wide at the base. Disc with several pubescent lines at the base between the basal auricles. Column short and stout, about 8 mm long with a pair of linear or linear-triangular arms at the apex. Ovary semiglobose with a pair of ridges at the tip, densely papillose. Pollinia 4, complanate obovoid.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 80831 Quisumbing,* May 26, 1930. The living plants were epiphytes collected from the forests of Atimonan, Tayabas Province, Luzon. Sepals and petals barium yellow to citron yellow barred with cinnamon brown. The middle lobe of the labellum white, the lateral lobes marguerite yellow and spotted at the base with coral red on top. Gynostemium barium yellow.

While this species was originally described as a member of the genus *Trichoglottis,* it is certainly aberrant from the general conception of that group in its relatively elongate several-flowered inflorescences of large flowers and especially in its spurless labellum.

Like the genus *Vandopsis* Pfitz., this species has an ecalcarate lip with a laterally flattened terminal lobe. But, unlike all members of that genus examined, it possesses conspicuous triangular-lanceolate side lobes.

In this latter feature the present species is in exact accord with the concept of Reichenbach when he transcribed *Trichoglottis philippinensis* Lindl., with its very similar lip structure, into *Stauropsis*. This genus was so-named, of course, from the spreading star-shaped lobes of the lip.

We are, therefore, of the opinion that this species and *Trichoglottis philippinensis* would best be reinstated as members of the genus *Stauropsis* Reichb. f.

Together with its rather localized Philippine occurrence, this species occurs in several parts of eastern tropical Asia; namely, Siam, Lankawi, etc.

This is a rare species in the Philippines, locally known as "*Renanthera alba*." It is characterized by the pale yellowish green oblong leaves, the peculiar labellum, and the horns at the tips of the sepals and petals.

ILLUSTRATIONS

PLATE 1

FIG. 1. *Agrostophyllum luzonense* sp. nov., front view of a flower, × 4.
2. *Agrostophyllum luzonense* sp. nov., side view of a flower, × 4.
3. *Dendrobium modestum* Reichb. f., side view of a flower, × 2.
4. *Dendrobium modestum* Reichb. f., front view of a flower, × 2.
5. *Dendrobium batanense* sp. nov., front view of a flower, × 1.
6. *Dendrobium batanense* sp. nov., side view of a flower, × 1.
7. *Spathoglottis plicata* Bl. var. *parsonsii* var. nov., front view of a flower, × 1.
8. *Spathoglottis plicata* Bl. var. *parsonsii* var. nov., side view of a flower, × 1.

PLATE 2

FIG. 1. *Dendrobium fairchildae* sp. nov., front view of a flower, × 1.
2. *Dendrobium fairchildae* sp. nov., side view of a flower, × 1.
3. *Dendrobium fairchildae* sp. nov., front view of a flower, × 1.
4. *Stauropsis fasciata* Benth., front view of a flower, × 1.
5. *Stauropsis fasciata* Benth., side view of a flower, × 1.
6. *Robiquetia pantherina* (Kränzl.) Ames, front view of a flower, × 2.
7. *Robiquetia pantherina* (Kränzl.) Ames, side view of a flower, × 2.
8. *Dendrobium junceum* Lindl., front view of a flower, × 1.
9. *Dendrobium junceum* Lindl., side view of a flower, × 1.

PLATE 3

FIG. 1. *Renanthera storiei* Reichb. f. var. *philippinensis* var. nov., front view of a flower, × 2.
2. *Renanthera storiei* Reichb. f. var. *philippinensis* var. nov., side view of a flower, × 2.
3. *Bulbophyllum cleistogamum* Ridl., front view of a flower, × 1.
4. *Bulbophyllum cleistogamum* Ridl., side view of a flower, × 1.
5. *Bulbophyllum maquilingense* sp. nov., front view of a flower, × 2.
6. *Bulbophyllum maquilingense* sp. nov., side view of a flower, × 2.
7. *Vanda merrillii* sp. nov., front view of a flower, × 1.
8. *Vanda merrillii* sp. nov., side view of a flower, × 1.

PLATE 4

Agrostophyllum luzonense sp. nov.: *1*, apical portion of an inflorescence showing bracts, and side view of the column, × 2; *2*, a bract, × 7.5; *3*, dorsal sepal, × 7.5; *4*, lateral sepal, × 7.5; *5*, petal, × 7.5; *6*, front view of labellum, × 7.5; *7*, side view of labellum,

$\times$ 7.5; *8*, side view of column and pedicellate ovary, $\times$ 7.5; *9*, front view of column and pedicellate ovary, $\times$ 7.5; *10*, view of anther from above, $\times$ 18.5; *11*, view of anther from below, $\times$ 18.5; *12*, front view of pollinium, $\times$ 18.5; *13*, side view of pollinium, $\times$ 18.5.

PLATE 5

Dendrobium batanense sp. nov.: *1*, habit of a single plant, $\times$ 0.5; *2*, basal portion of a stem showing pseudobulb with three internodes, $\times$ 0.5; *3*, dorsal sepal, $\times$ 2; *4*, lateral sepal, spur and pedicellate ovary, $\times$ 2; *5*, petal, $\times$ 2; *6*, front view of labellum, $\times$ 2; *7*, front view of column, $\times$ 2; *8*, side view of column, pedicellate ovary and bracts, $\times$ 2; *9*, view of anther from above, $\times$ 7.5; *10*, group of pollinia, $\times$ 7.5; *11*, two pollinia, $\times$ 7.5; *12*, fruit, $\times$ 1.

PLATE 6

Dendrobium modestum Reichb. f.: *1*, habit, about one-third natural size; *2*, dorsal sepal, $\times$ 4; *3*, lateral sepal, $\times$ 4; *4*, lateral sepal and spur, $\times$ 4; *5*, petal, $\times$ 4; *6*, front view of labellum, $\times$ 4; *7*, side view of labellum, $\times$ 4; *8*, side view of column, $\times$ 4; *9*, front view of column, $\times$ 4; *10*, view of anther from below, $\times$ 10; *11*, side view of anther, $\times$ 10; *12*, pollinia, $\times$ 10.

PLATE 7

FIG. 1. *Dendrobium fairchildae* sp. nov.: *1*, dorsal sepal, $\times$ 1; *2*, exterior view of one lateral sepal and spur and partial view of the other lateral sepal, and the pedicellate ovary, $\times$ 1; *3*, interior view of a lateral sepal, spur and side view of the column and pedicellate ovary, $\times$1; *4*, petal, $\times$ 1; *5*, front view of (flattened) labellum, $\times$ 1; *6*, side view of labellum (natural position), $\times$ 1; *7*, front view of column, $\times$ 1; *8*, view of anther from above, $\times$ 6; *9*, view of anther from below, $\times$ 6; *10*, front view of pollinium, $\times$ 6; *11*, side view of two pollinia, $\times$ 6.

2. *Renanthera storiei* Reichb. f. var. *philippinensis* var. nov.: *12*, dorsal sepal, $\times$ 2; *13*, lateral sepal, $\times$ 2; *14*, petal, $\times$ 2; *15*, view of labellum and column from above, $\times$ 7.5; *16*, side view of labellum and column, $\times$ 7.5; *17*, front view of column, $\times$ 7.5; *18*, view of anther from below $\times$ 7.5; *19*, front and side views of pollinia, $\times$ 7.5.

PLATE 8

Dendrobium junceum Lindl.: *1*, dorsal sepal, $\times$ 2; *2*, lateral sepal, $\times$ 2; *3*, lateral sepal and spur, $\times$ 2; *4*, petal, $\times$ 2; *5*, front view of labellum, $\times$ 2; *6*, side view of labellum, $\times$ 2; *7*, front view of column, $\times$ 2; *8*, side view of column, $\times$ 2; *9*, view of anther from above, $\times$ 6; *10*, view of anther from below, $\times$ 6.

PLATE 9

Bulbophyllum cleistogamum Ridl.: *1*, tip of the inflorescence showing bracts, $\times$ 2; *2*, dorsal sepal, $\times$ 2; *3*, lateral sepal, $\times$ 2; *4*, petal,

× 18; *5*, side view of column, labellum and pedicellate ovary, × 2; *6*, front view of labellum and column, × 2; *7*, apical region of the column, × 4; *8*, view of anther from above, × 10; *9*, view of anther from below, × 10.

PLATE 10

Bulbophyllum maquilingense sp. nov.: *1*, habit, approximately × 2; *2*, view of dorsal sepal from back, × 4; *3*, side view of dorsal sepal, × 4; *4*, outer view of lateral sepal, × 4; *5*, inner view of lateral sepal, × 4; *6*, outer view of petal, × 4; *7*, inner view of petal, × 4; *8*, front view of labellum, × 4; *9*, side view of labellum, column and pedicellate ovary, × 4; *10*, front view of column, × 18.

PLATE 11

FIG. 1. *Vanda merrillii* sp. nov.: *1*, dorsal sepal (natural position), × 1; *2*, lateral sepal (natural position), × 1; *3*, petal (natural position), × 1; *4*, front view of labellum, × 2; *5*, side view of labellum, column and anther, × 2; *6*, view of column from above, × 3.65; *7*, view of anther from above, × 3.65; *8*, view of anther with pollinia, from below, × 3.65; *9*, pollinia, × 8; *10*, fruit, × 0.5.

2. *Robiquetia pantherina* (Kränzl.) Ames: *11*, side view of dorsal sepal, × 3; *12*, front view of dorsal sepal, × 3; *13*, petal, × 3; *14*, lateral sepal, × 3; *15*, side view of column, anther, labellum and spur, × 4.25; *16*, view from above of column, anther and labellum, × 4; *17*, back view of spur, × 3.5; *18*, longitudinal section of labellum and spur showing prominent scale on the anterior wall, × 3.5; *19*, median section of spur showing partition, × 3; *20*, view of anther from below, × 3; *21*, pollinia, × 3.

PLATE 12

Stauropsis fasciata Benth.: *1*, interior view of dorsal sepal, × 2; *2*, side view of dorsal sepal, × 2; *3*, interior view of lateral sepal, × 2; *4*, interior view of petal, × 2; *5*, view of labellum and column from above, × 4; *6*, side view of labellum and column, × 4; *7*, side view of anther, × 4; *8*, view of anther from above, × 4; *9*, view of anther from below, × 4; *10*, front view of pollinium, × 15; *11*, side view of pollinium, × 15.

PLATE 13

Agrostophyllum luzonense sp. nov.; habit, much reduced.

PLATE 14

Agrostophyllum luzonense sp. nov.; tops of three flowering stems, approximately natural size.

PLATE 15

Spathoglottis plicata Bl. var. *parsonsii* var. nov.; habit, much reduced.

PLATE 16

Dendrobium batanense sp. nov.; habit, much reduced.

PLATE 17

FIG. 1. *Spathoglottis plicata* Bl. var. *parsonsii* var. nov.; flowers, very slightly reduced.
2. *Dendrobium batanense* sp. nov.; flowers, reduced.

PLATE 18

Dendrobium fairchildae sp. nov.; habit, very much reduced.

PLATE 19

Dendrobium fairchildae sp. nov.; inflorescence, approximately one-half natural size.

PLATE 20

FIG. 1. *Dendrobium junceum* Lindl.; habit, very much reduced.
2. *Dendrobium junceum* Lindl.; flowers, slightly reduced.

PLATE 21

Dendrobium junceum Lindl.; tops of flowering stems, very much reduced.

PLATE 22

Dendrobium modestum Reichb.f.; habit, very much reduced.

PLATE 23

FIG. 1. *Bulbophyllum cleistogamum* Ridl.; flower and old fruit capsule. approximately natural size.
2. *Bulbophyllum cleistogamum* Ridl.; habit, very much reduced.

PLATE 24

FIG. 1. *Renanthera storiei* Reichb.f. var. *philippinensis* var. nov.; habit, very much reduced.
2. *Renanthera storiei* Reichb.f. var. *philippinensis* var. nov.; inflorescence, reduced.

PLATE 25

Vanda merrillii sp. nov.; habit, very much reduced.

PLATE 26

Vanda merrillii sp. nov.; inflorescence, slightly reduced.

PLATE 27

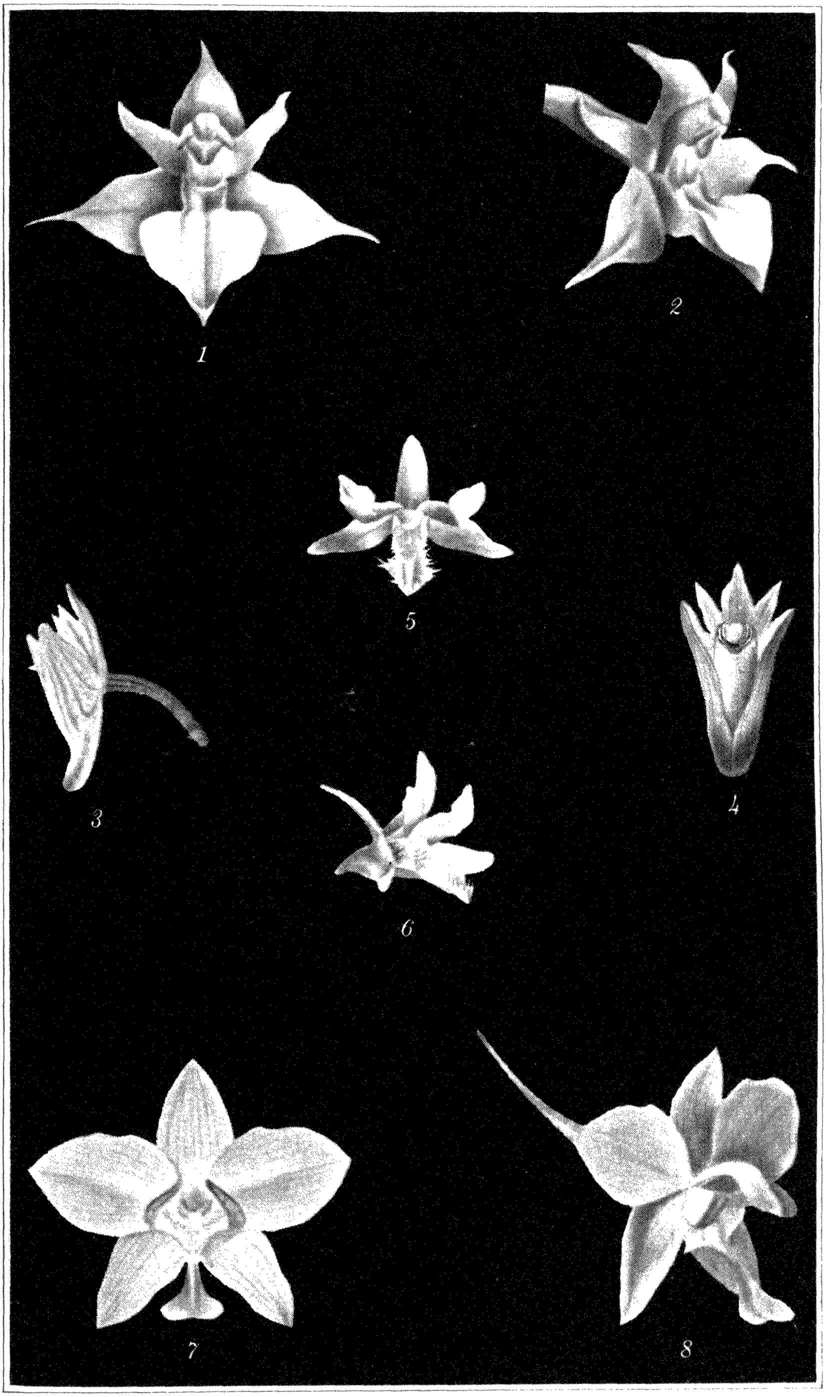
FIG. 1. *Robiquetia pantherina* (Kränzl.) Ames; habit, very much reduced.
2. *Robiquetia pantherina* (Kränzl.) Ames; flowers, approximately natural size.

PLATE 28

Stauropsis fasciata Benth.; habit, very much reduced.

PLATE 29

Stauropsis fasciata Benth.; flower, slightly enlarged.



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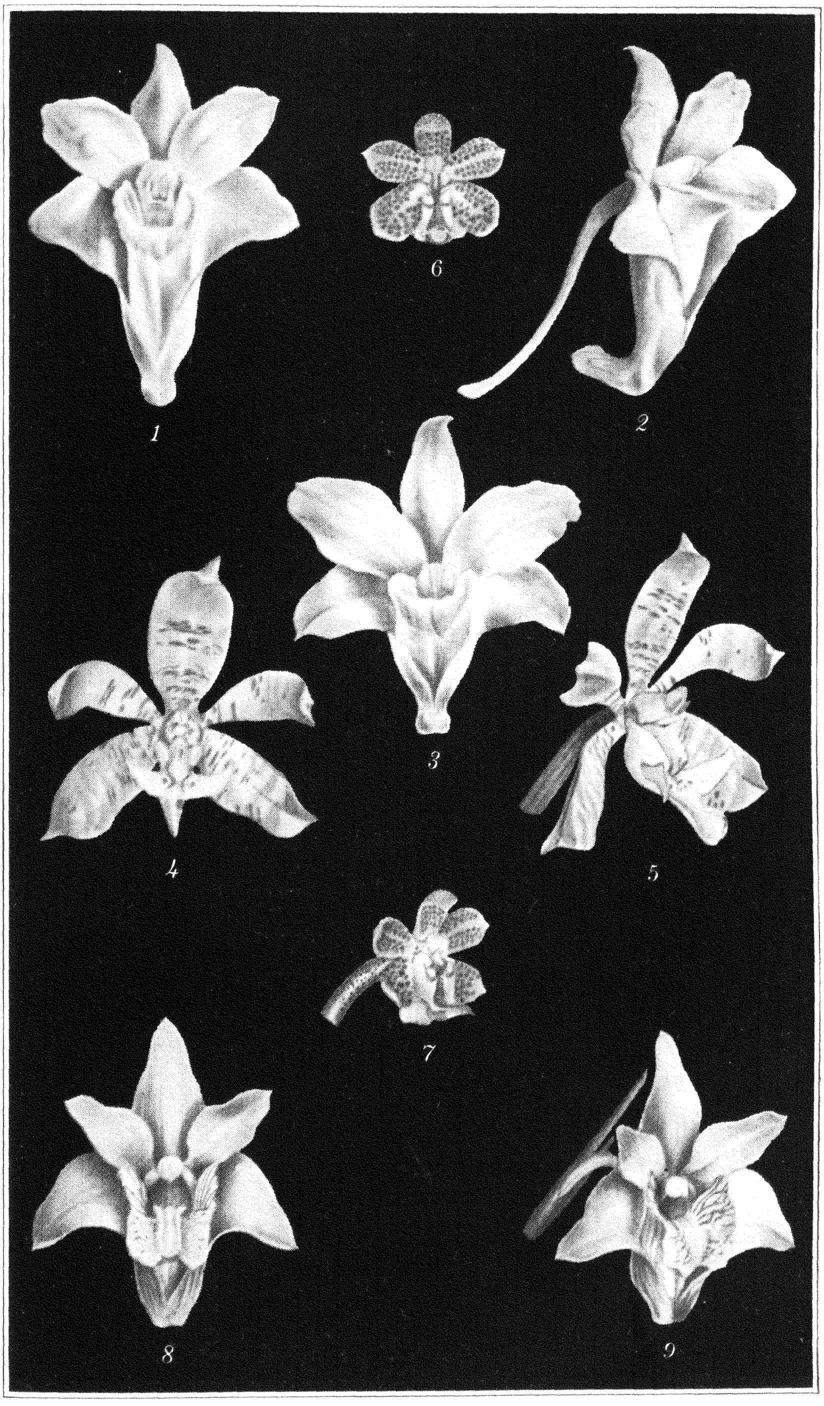

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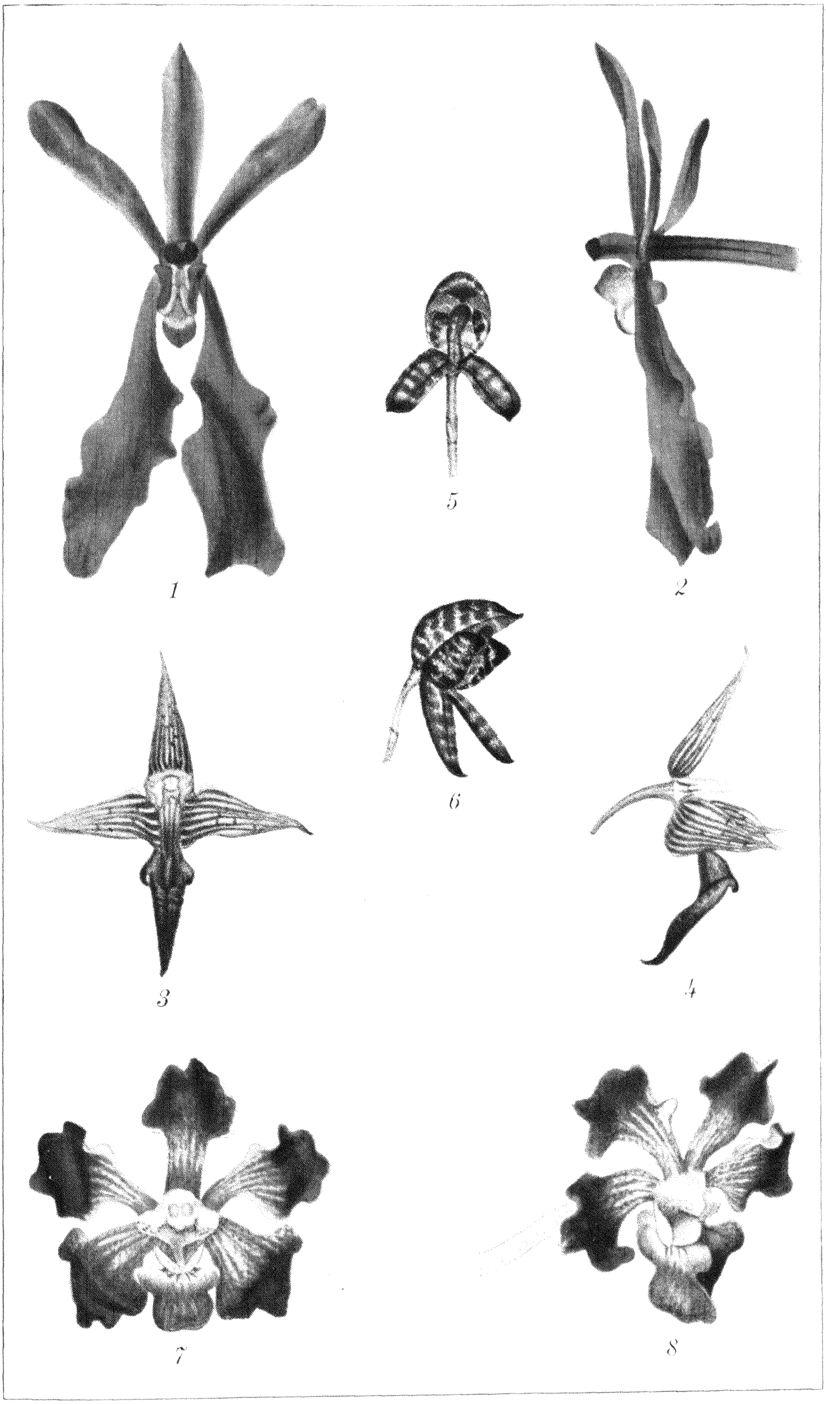

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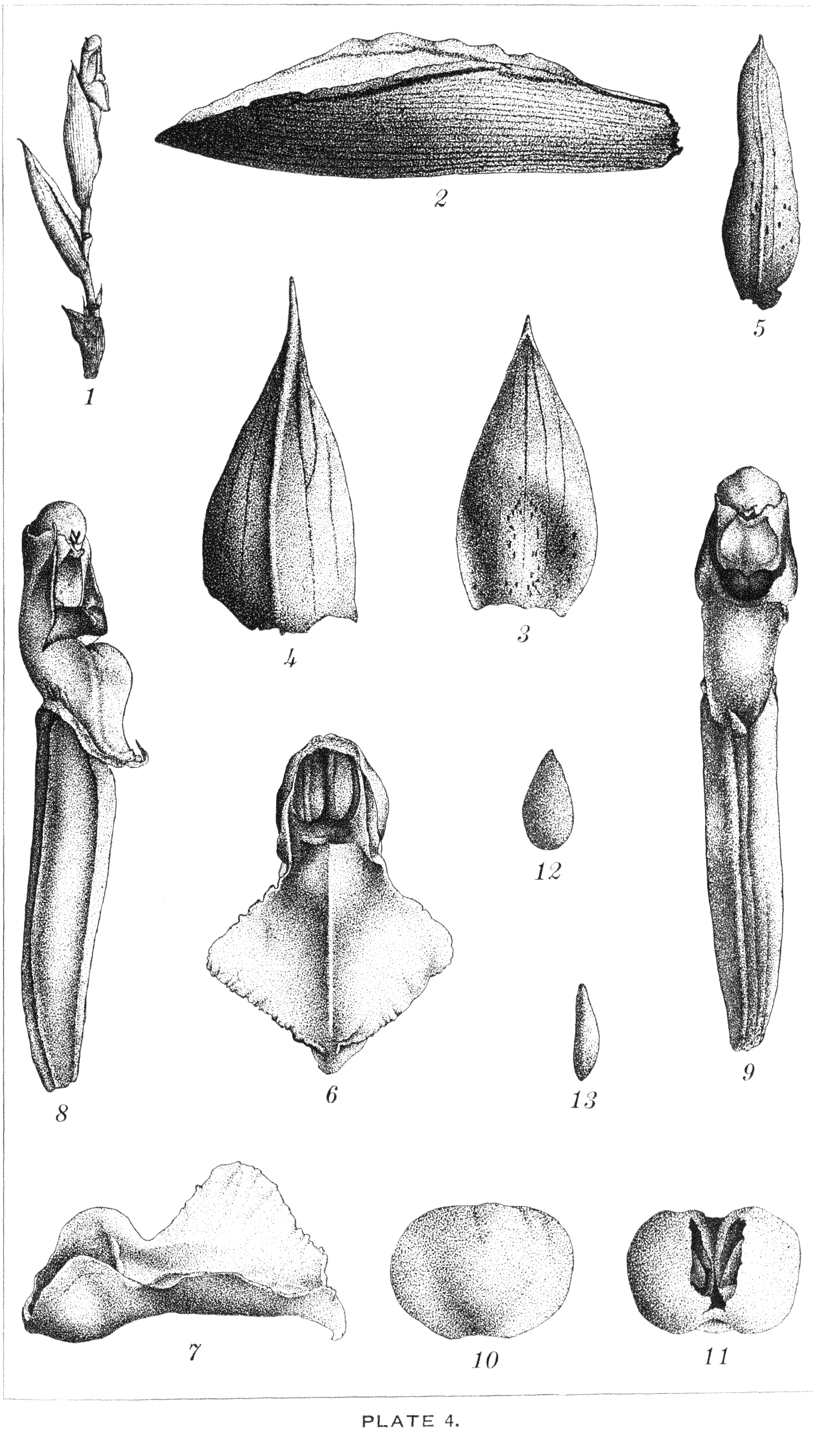

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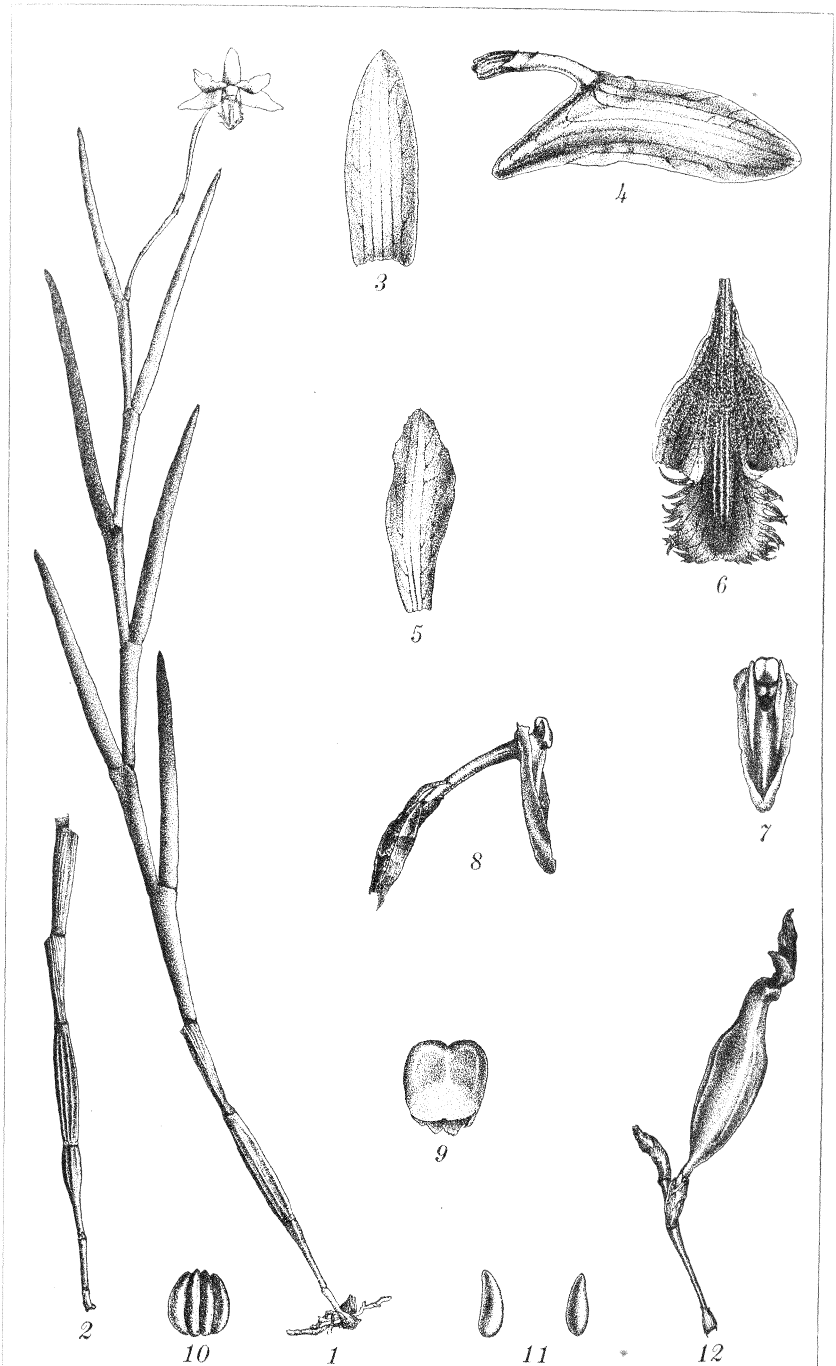

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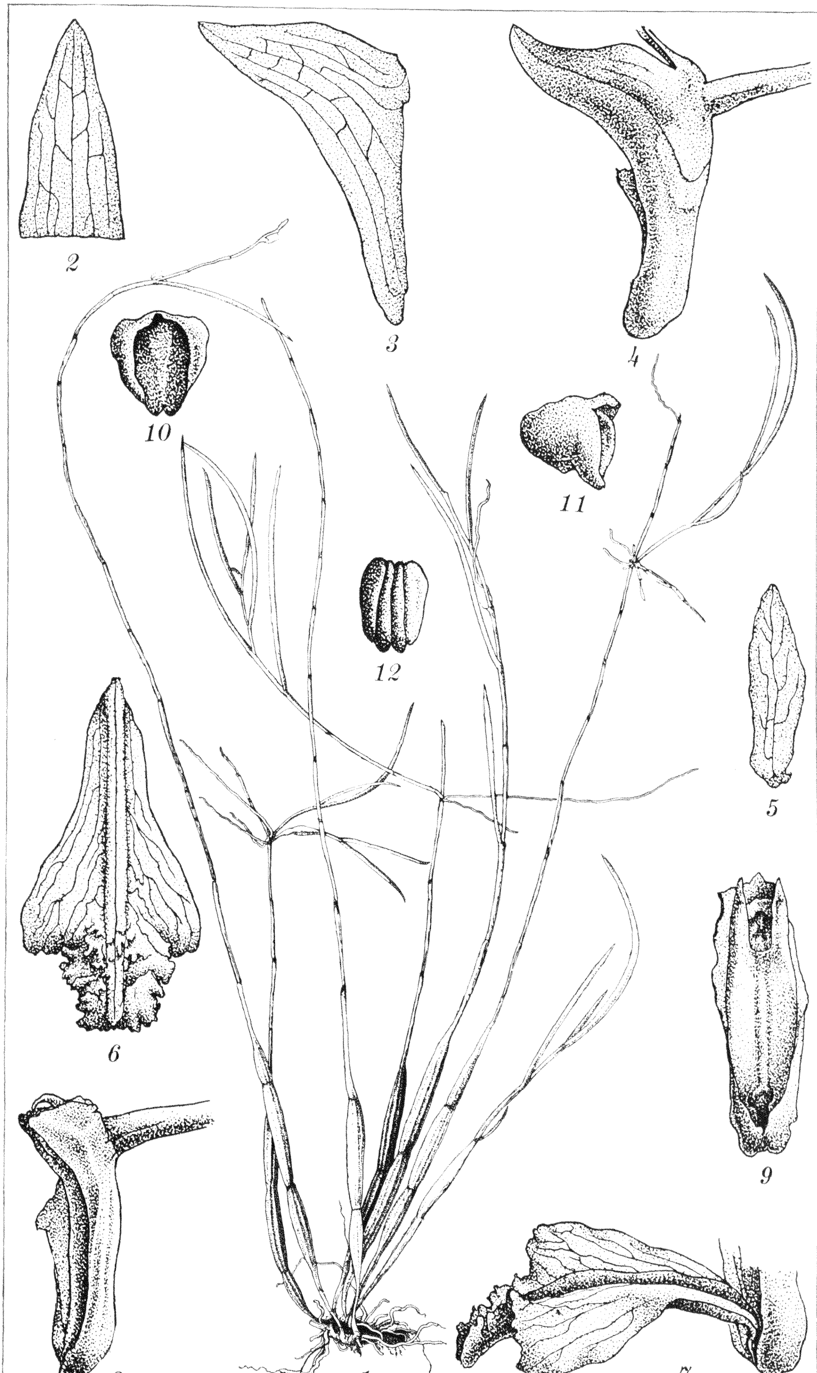

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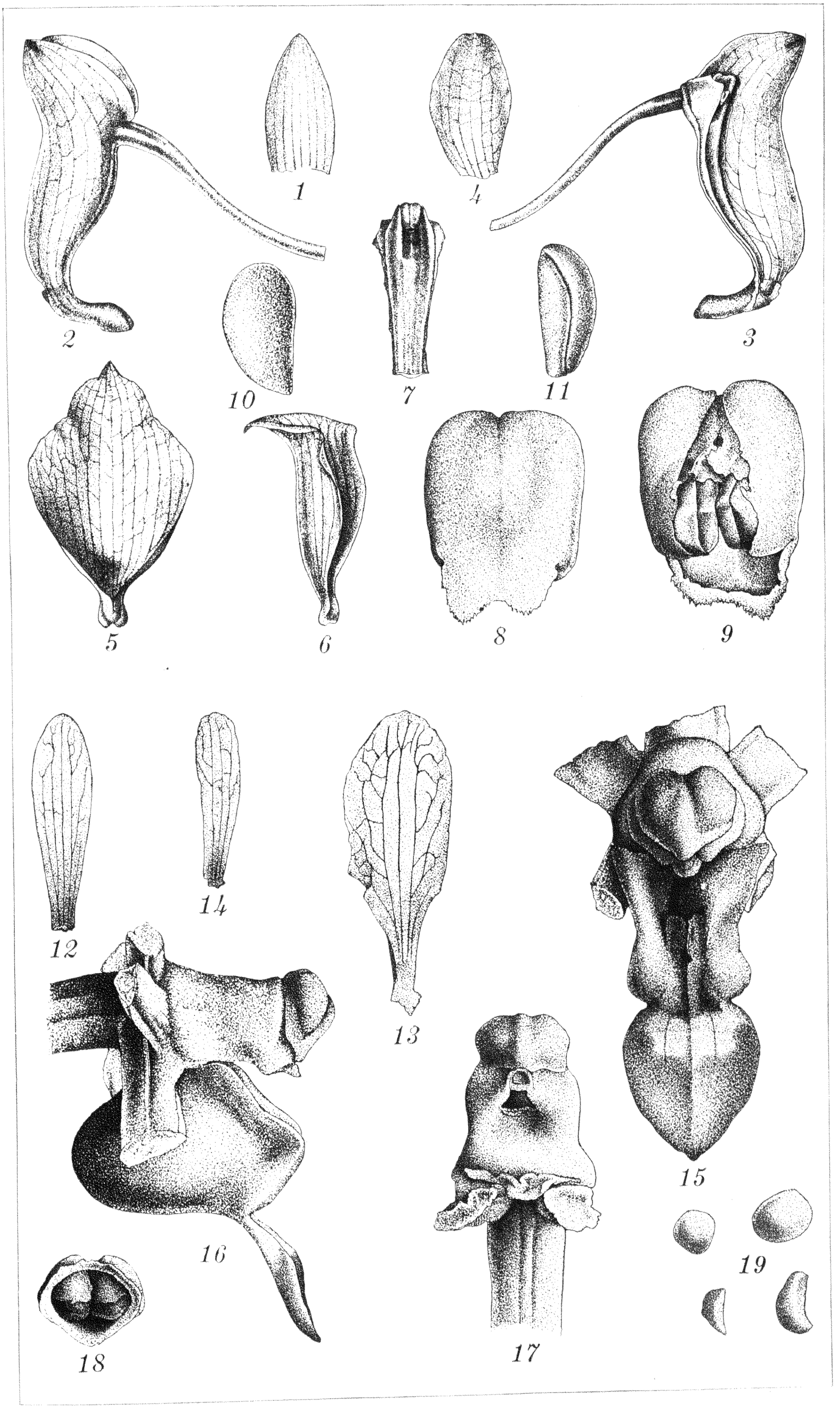

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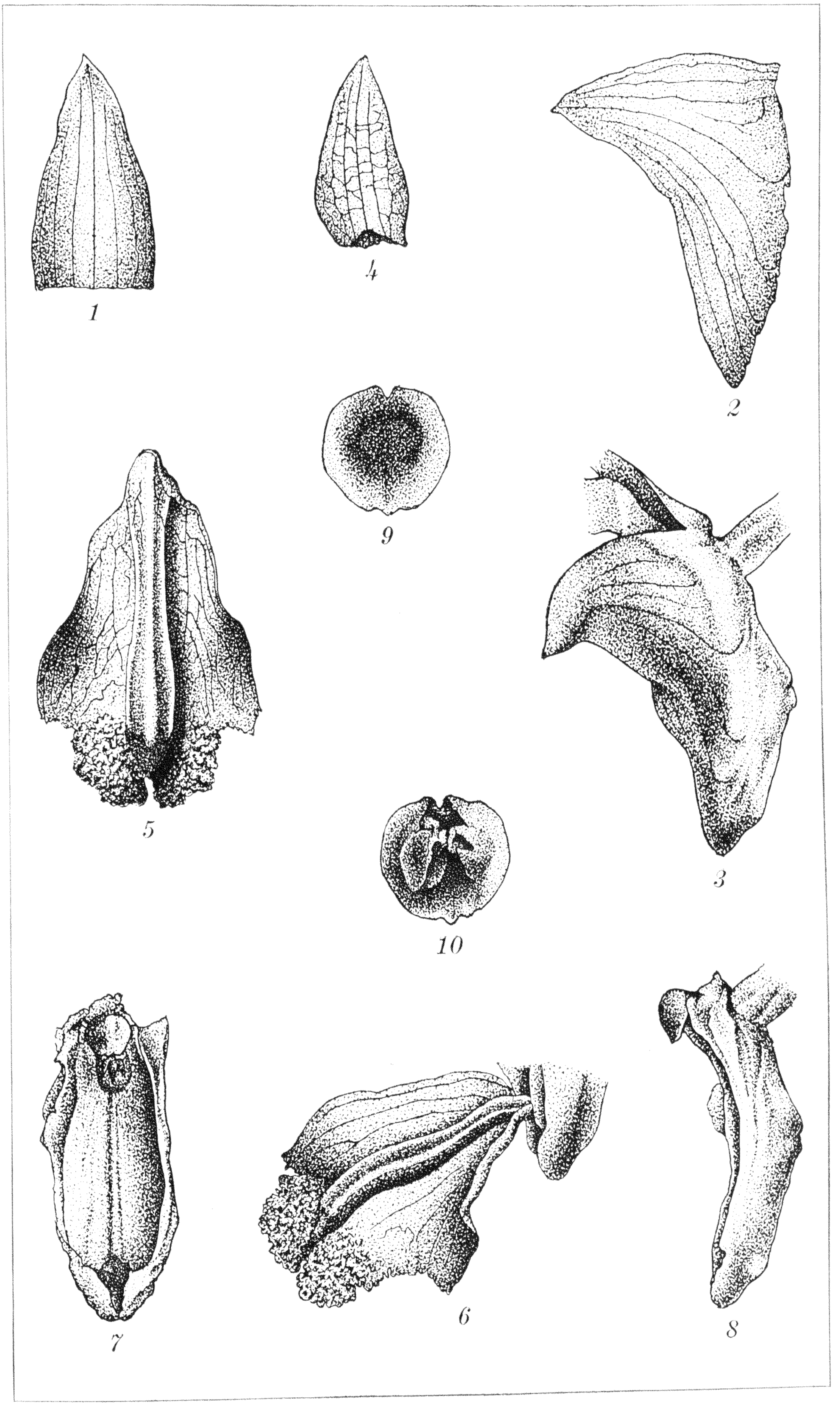

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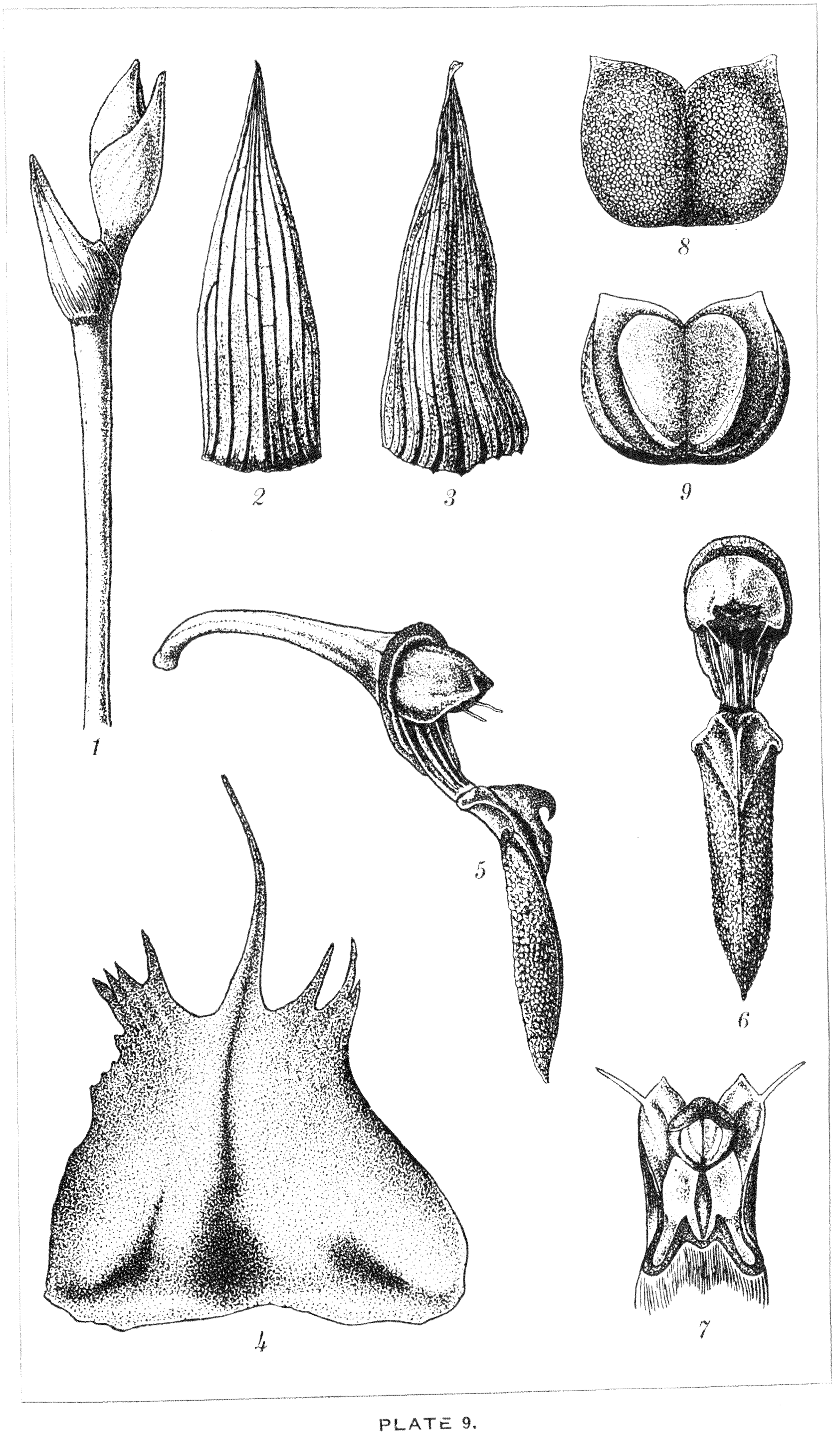

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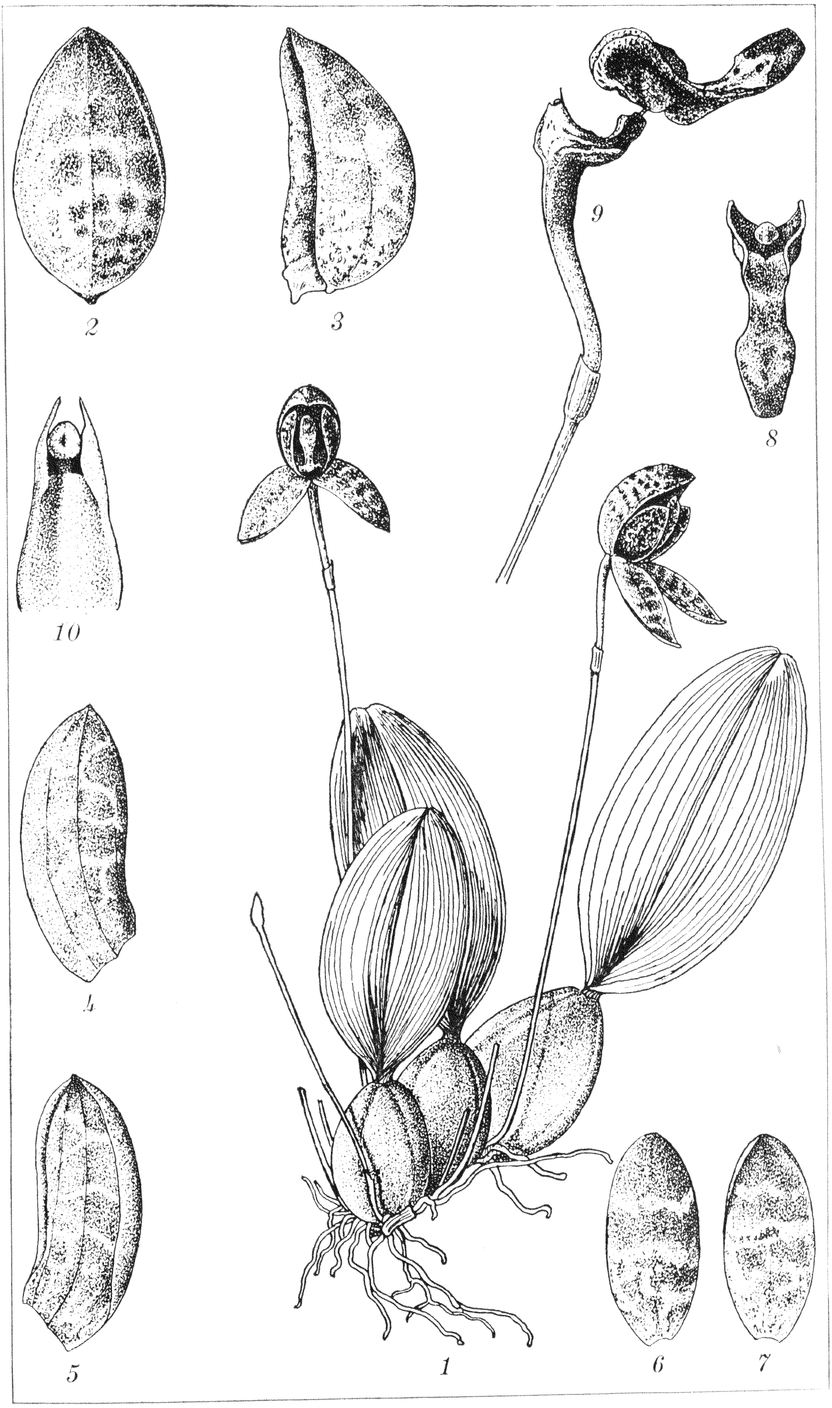


PLATE 10.

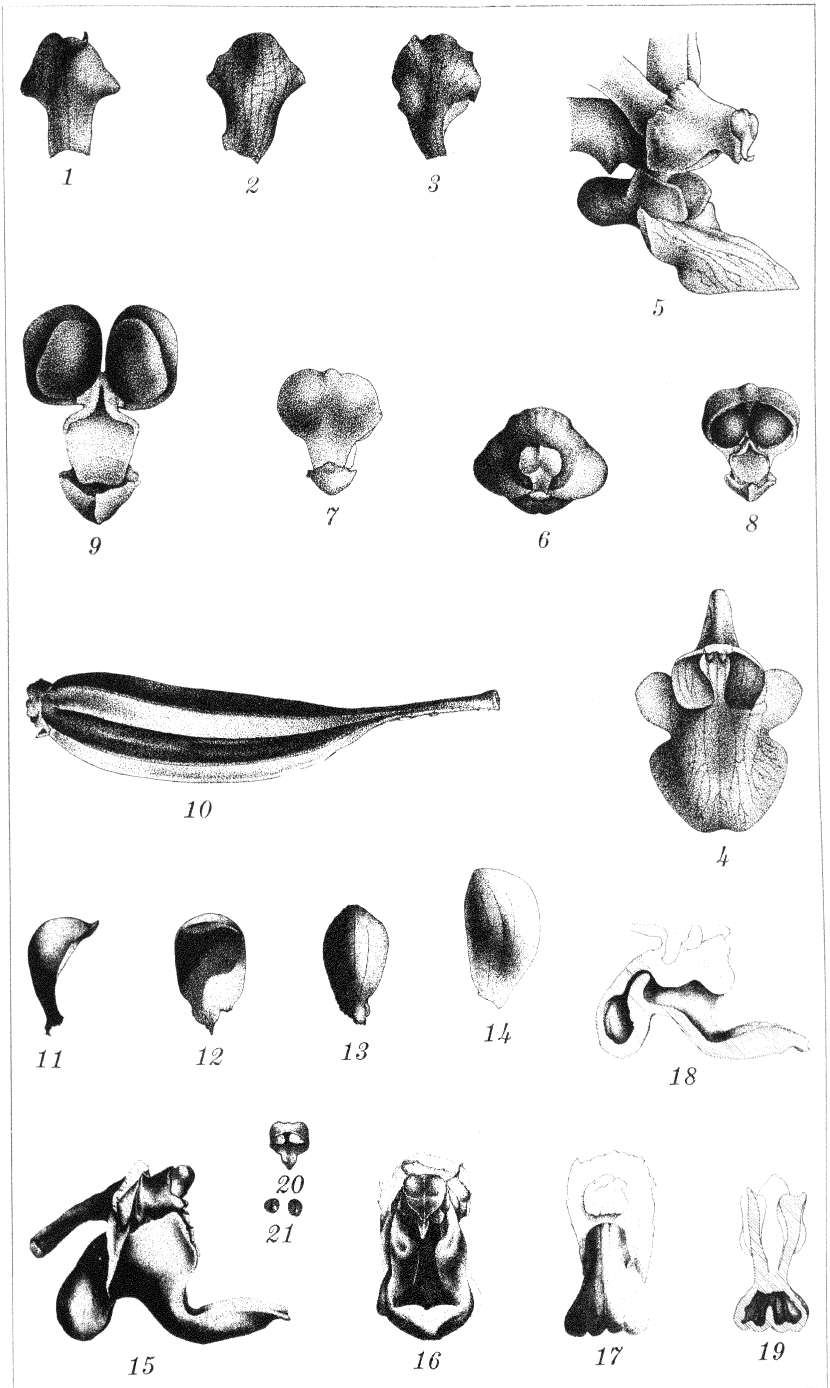


PLATE 11.

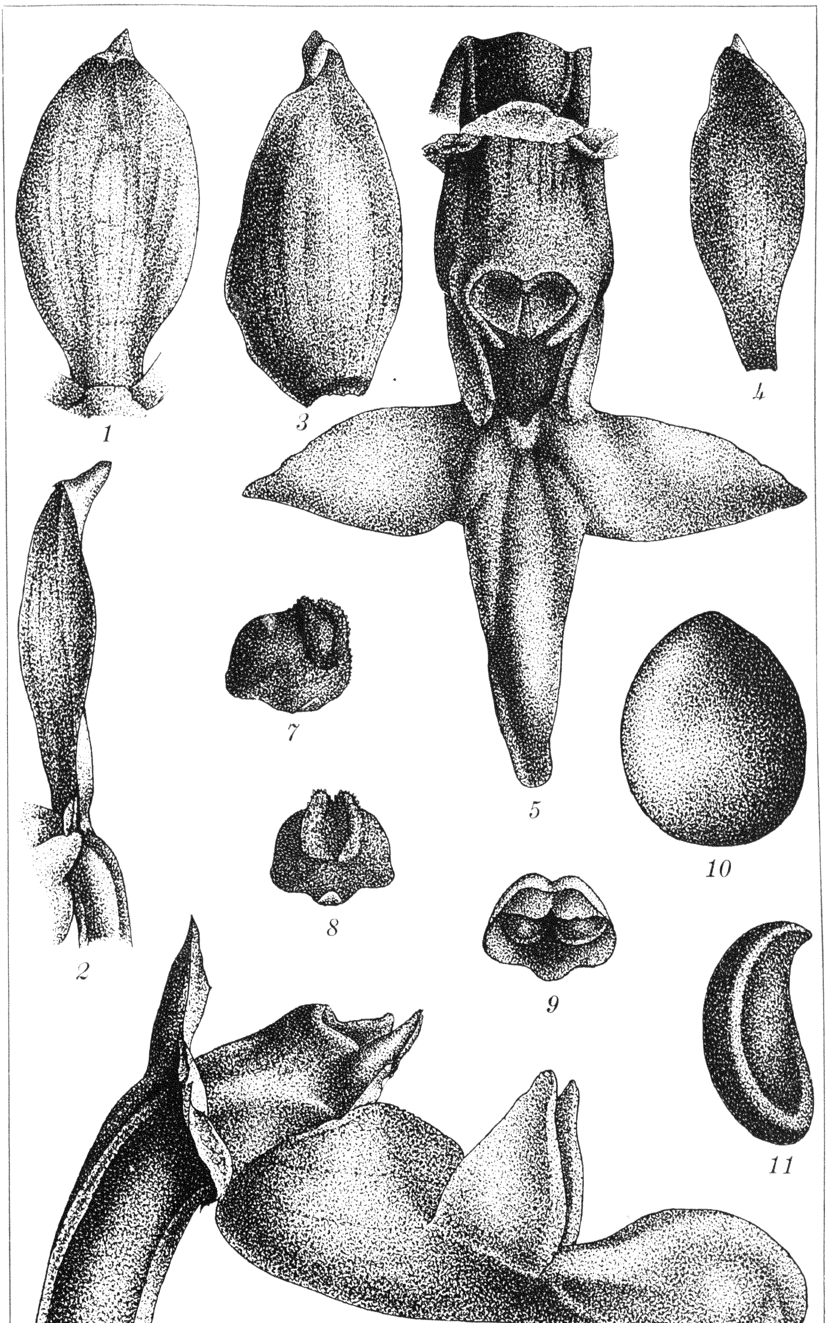


PLATE 12.

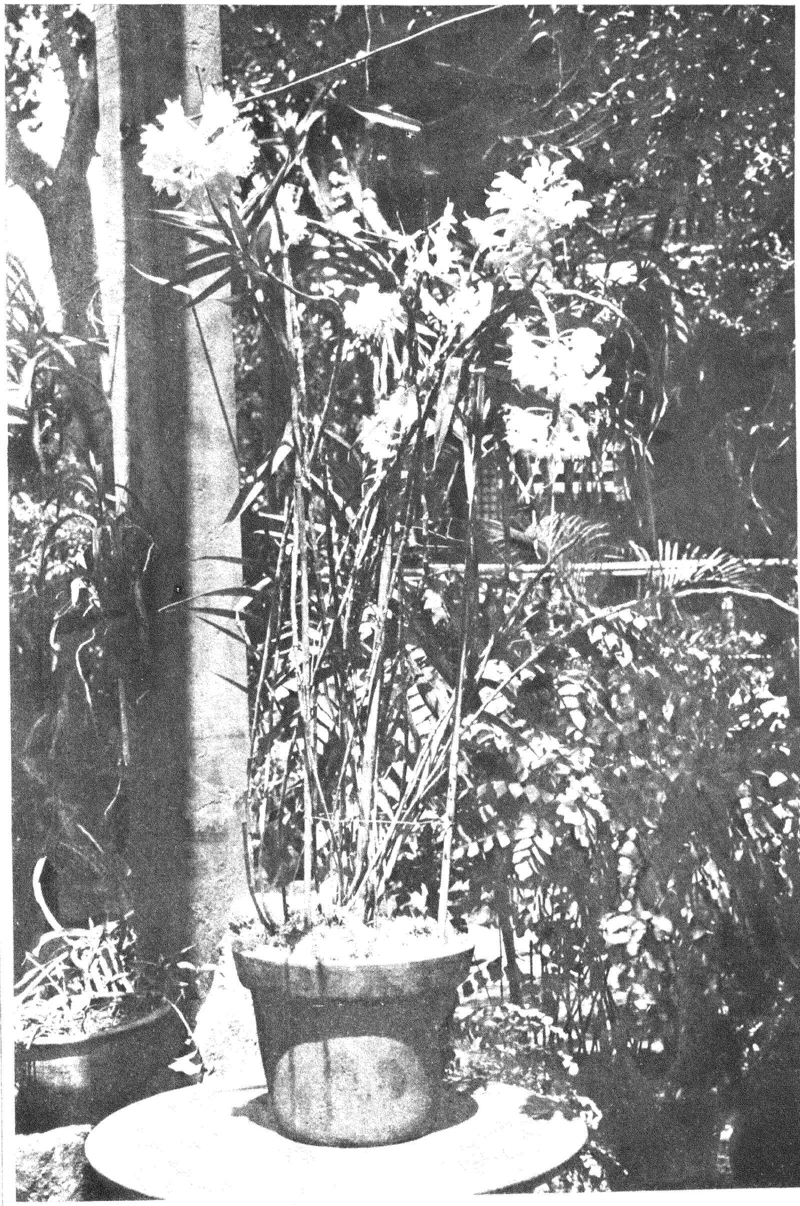
PLATE 13.

PLATE 14.

PLATE 15.

PLATE 16.

PLATE 17.



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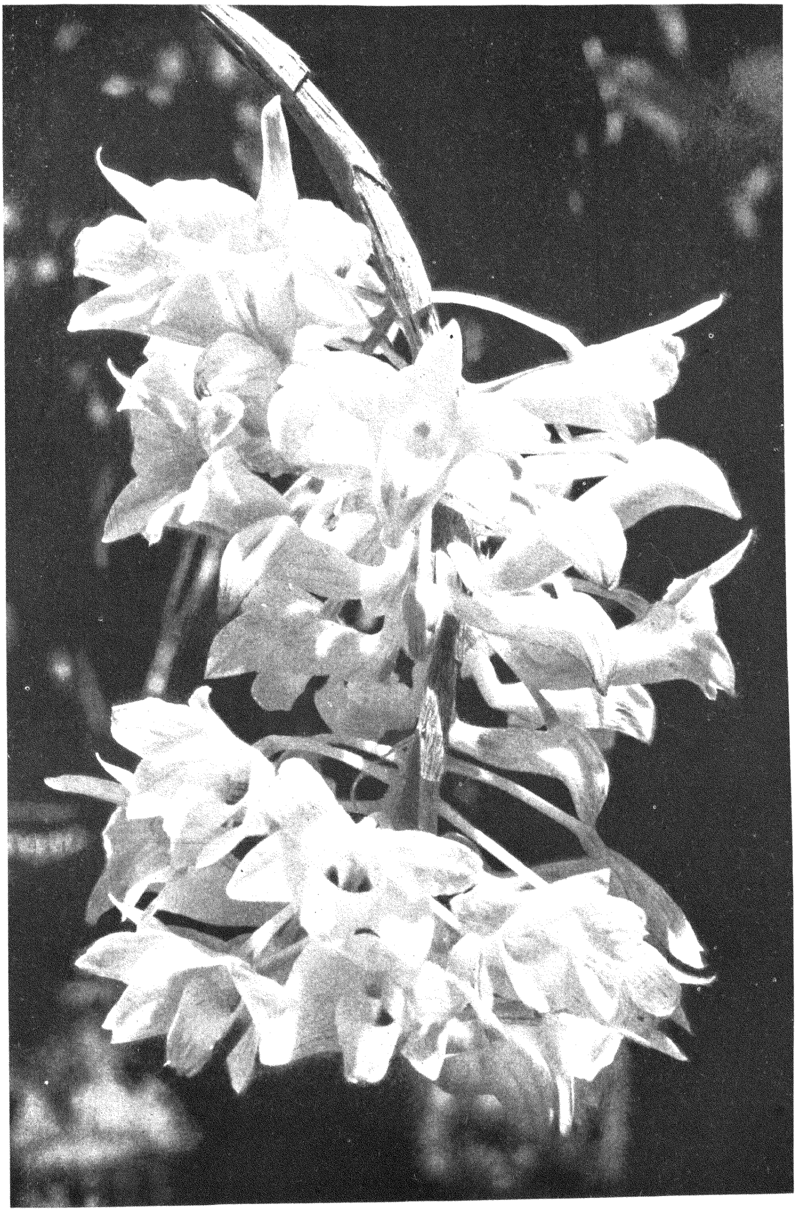

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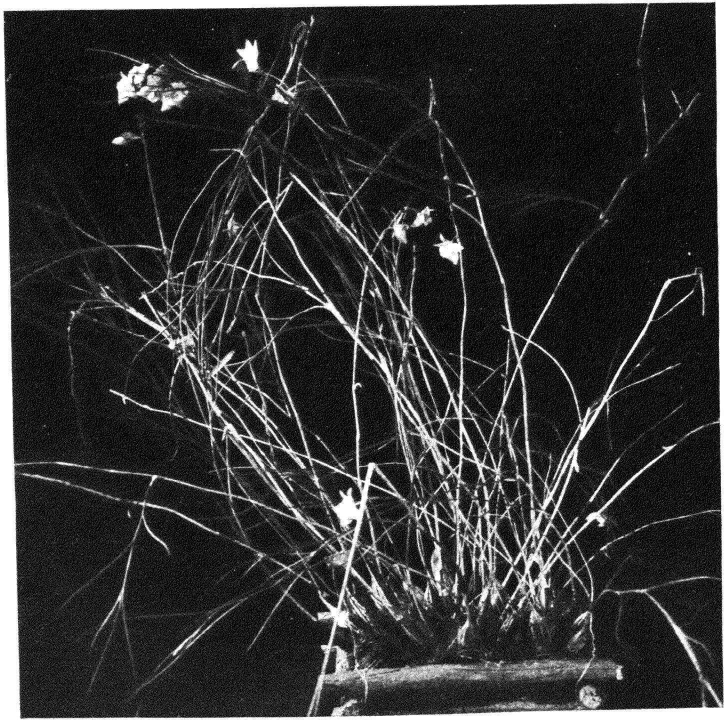

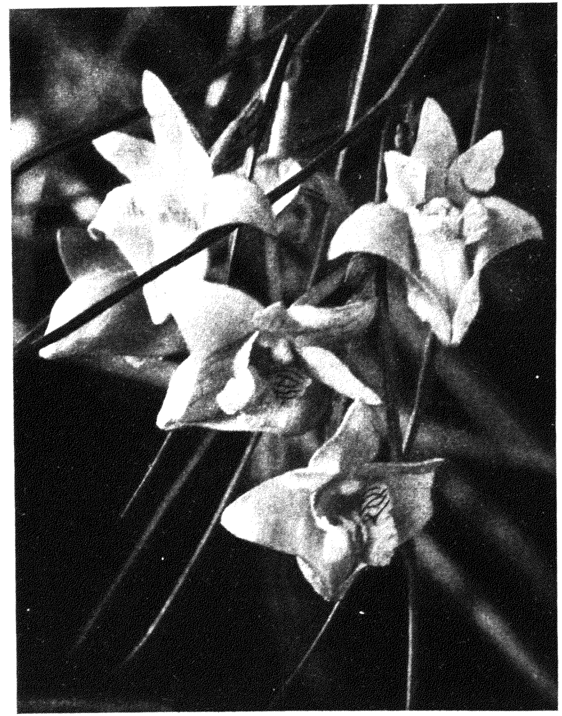

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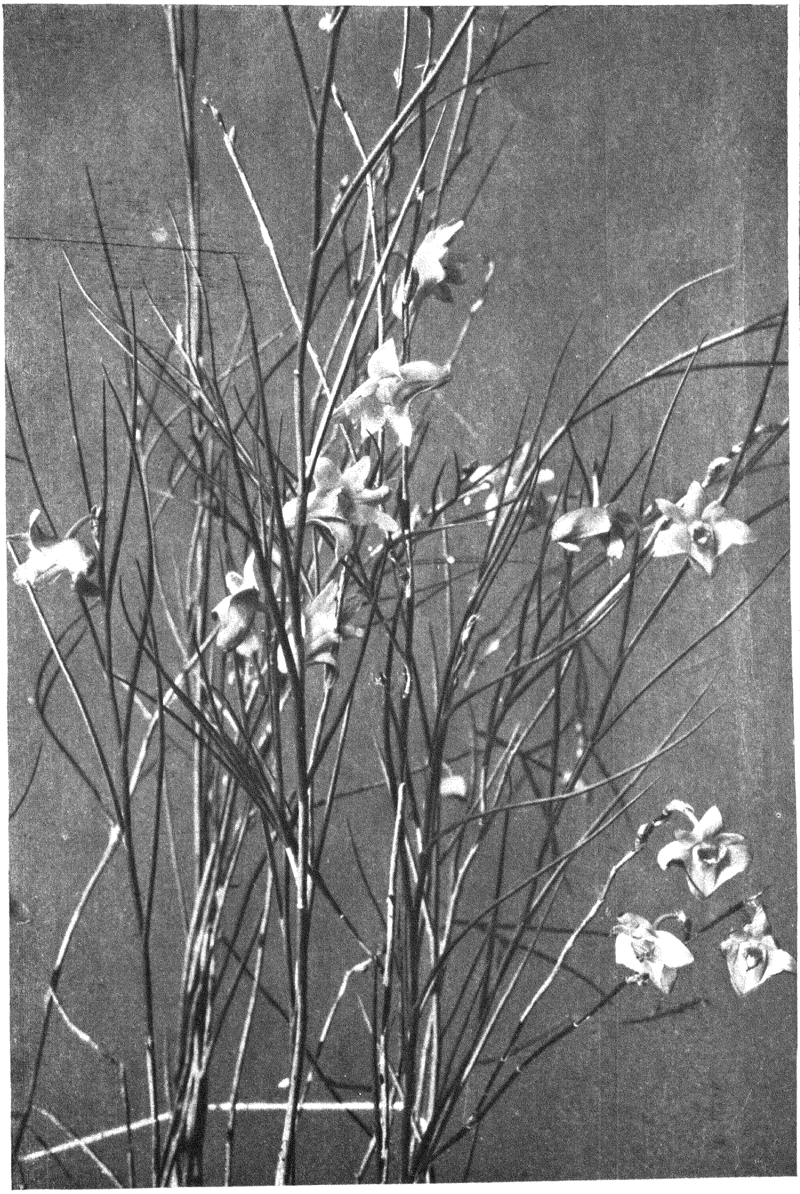

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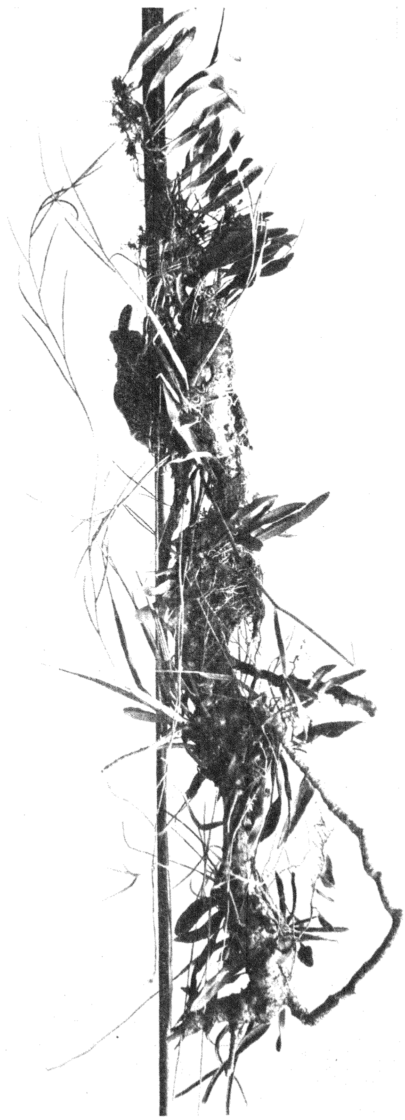

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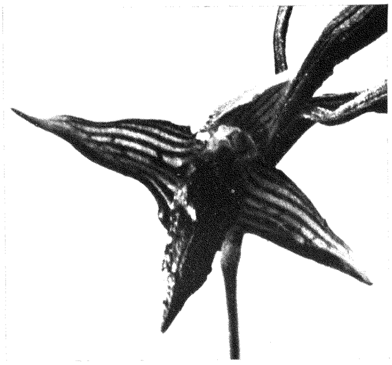

PLATE 23.

PLATE 24.

PLATE 25.

PLATE 26.

PLATE 27.

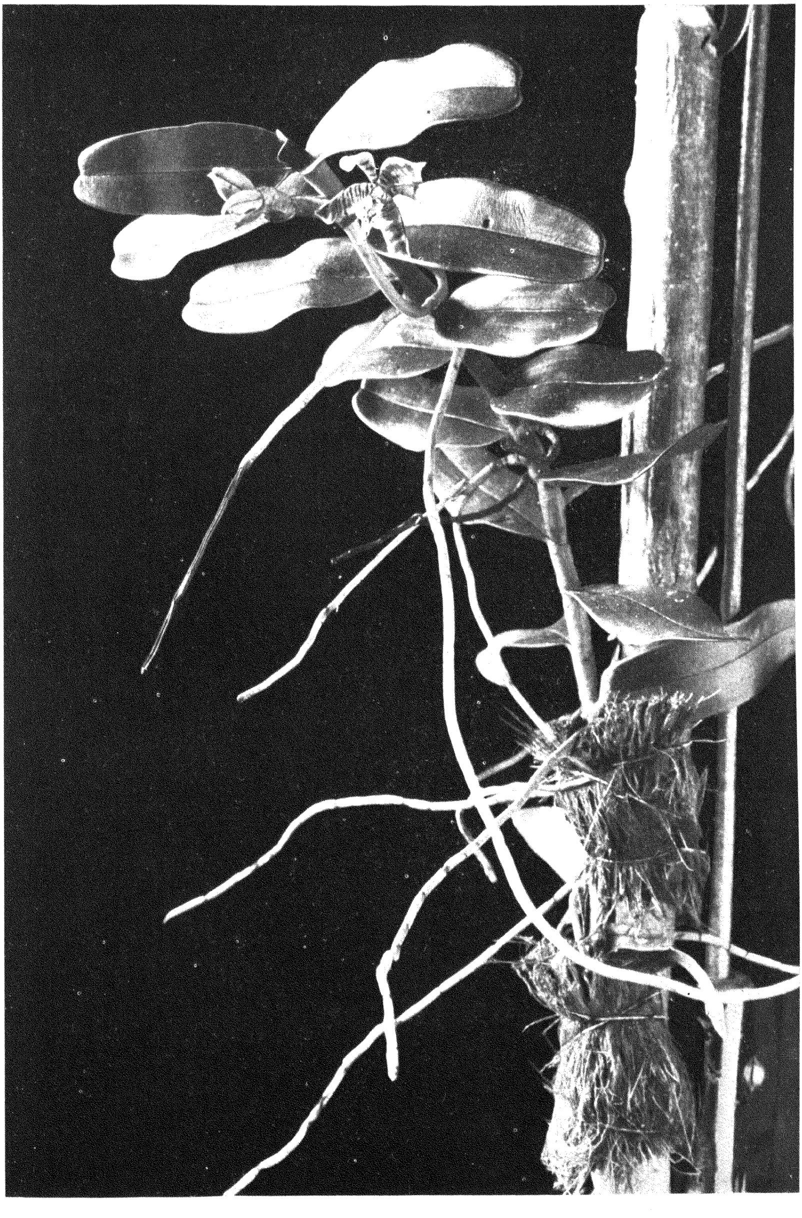

PLATE 28.

PLATE 29.

MUTATION STUDIES ON PHILIPPINE WILD DROSOPHILA

By LEOPOLDO S. CLEMENTE

Of the Department of Zoölogy, University of the Philippines, Manila

THREE PLATES

ABSTRACT

Mutation studies were made on two forms of Philippine wild *Drosophila;* one is "banded," due to the presence in both sexes of prominent black bands at the abdominal region, and the other is "bandless," due to the absence in both sexes of such abdominal bands. Numerous mutations were observed from the bandless form, but none from the banded. Autosomal as well as sex-linked mutations were found, although most of them are of the former type. The different mutations reported in this paper in the order of their discovery are "rose-eye," which is a sex-linked recessive to red-eye; "vestigial wing," which is an autosomal recessive to long wing; "eyeless," which is an autosomal recessive to an eyed condition; and "purple-eye," which is an autosomal recessive to red-eye. The first two mutations originated from the bandless Cebu wild *Drosophila,* while the last two from the bandless Manila wild *Drosophila.* Conclusive evidence was found to show that the banded and bandless forms are of different species; they appear different externally, one mutates while the other does not, and the two do not cross.

INTRODUCTION

This work on Philippine wild *Drosophila* has for its purpose primarily to produce mutant strains for use in our course in zoölogy to demonstrate Mendelian principles, and secondarily to work out the genetics of this Philippine form. No mutation in Philippine *Drosophila* has been reported, although various attempts have been made to produce mutations, especially by Dr. P. B. Sivickis, of the Department of Zoölogy, University of the Philippines, and by Dr. N. B. Mendiola, of the College of Agriculture, Los Baños.

My first attempt along this line was made while I was connected with the Junior College at Cebu, Cebu Island. Wild flies collected there January 15, 1924, furnished the material for this series. In June, 1925, when I was transferred to Manila, the Cebu wild stocks and mutants were brought with me and the experiments were continued. Unfortunately, the wild stocks as well as the mutants died in the summer of 1926. The days became so hot during that summer that all efforts to save the flies failed. Luckily, the mode of inheritance of the mutants had been worked out before they died. A second attempt to continue the experiment was made June 1, 1926, when a new stock of wild flies was collected in Manila, Luzon Island.

While it is true that work of this nature on *Drosophila* has been done exhaustively by many investigators, especially by Morgan and his associates (1919) on *D. melanogaster*, by Lancefield (1922) on *D. obscura*, by Metz (1914) on *D. willistoni*, by Metz (1916) on *D. virilis*, and by Sturtevant (1921) on *D. simulans*, yet, considering the fact that the experimental materials used here are different, being Philippine forms, a repetition of similar work is still justifiable.

The results reported in this paper were those that I accumulated while I was in the Junior College at Cebu and also those that I and my students in genetics at Manila were able to obtain. All the illustrations were drawn by the artist of the Department of Zoölogy, Mr. Rafael A. Dayao.

MATERIALS AND METHODS

Two distinct forms of wild *Drosophila*,[1] "banded" and "bandless," that were collected from Cebu and Manila were used. There are thus "banded Cebu wild" as well as "banded Manila wild" and "bandless Cebu wild" as well as "bandless Manila wild." The "banded" form (Plate 1, figs. 1 and 2) is so-called because both the males and females are well-provided with prominent black bands on the abdominal region, similar to *D. melanogaster*. This black marking is especially well-developed in the male, where the entire caudal end of the abdomen is colored solid black. This difference in the color markings of the male and female of the banded form makes the sexing very easy. In addition to the above difference, there is a row of prominent spines or a comb at the inner surface of the distal end of the

[1] The species is undetermined; however, samples of the flies were sent to Dr. A. H. Sturtevant, California Institute of Technology, Pasadena, California, for identification.

first tarsal segment of the male (Plate 1, fig. 6), while the female has none. This comb arrangement is exactly the same as in *D. melanogaster.* Both sexes of the banded form have a dark gray body, long wings, and red eyes.

The bandless form (Plate 1, figs. 3 and 4) has only a faint pigmentation at the junction of the abdominal segments in males and females, thus sexing of this form is rather difficult. The surest way to distinguish the male from the female in this form, in addition to differences in body size, shape of the abdomen, etc., is to look for a group of peglike bristles at the caudoventral end of the abdomen. This is absent in the female. Unlike the banded form, there is a complete absence of comb even in the proleg of the male (Plate 1, fig. 5). Both sexes of this form have a light gray body, long wings, and red eyes (Plate 2, fig. 1).

The banded and the bandless forms of *Drosophila* are invariably found together in the wild state, but the banded individuals are more numerous and more obtainable most of the time. The banded flies are more hardy than the bandless for they can breed in places where the latter would die out. They are more active, more prolific, and live longer than the bandless.

The laboratory food provided for them consisted of sliced ripe banana sprinkled with yeast foam tablets to hasten fermentation. The mixture is stirred until it is of a jellylike consistency. Food that is freshly prepared is found satisfactory, although food a day old is still usable, especially if kept in a cool place. Neither the food nor the containers are sterilized. The containers are washed in ordinary tap water, although in the presence of mold, boiling water is sometimes used.

Both 8-drachm vials and 120-cubic centimeter bottles were utilized for breeding containers; vials for test matings, and the bottles for culture stocks. Inside they were provided with a double fold of towel paper for the attachment of pupæ and for absorption of excess moisture. The plug used is kapok, a cheap cotton that is always available in Manila.

When the experiment was started, the flies were reared under laboratory conditions except that in summer they were kept in the ice box. Later, a frigidaire was installed in our laboratory to take the place of the ice box, which was found inadequate because the temperature could not be controlled. The frigidaire was kept running day and night at 25° C., although a slight fluctuation in temperature was noted in different chambers. The flies thrived so well in the frigidaire that they are now

being kept there throughout the year. The electrical current used is so little that it is almost negligible.

RESULTS

So far, no mutation of any kind has been observed from the banded form whether collected in Cebu or in Manila. On the other hand, both the Cebu and Manila bandless readily gave rise to mutations. What causes such a difference in their mutability is very hard to explain. It could not be due to the method used, for the two forms were subjected to the same treatment. It is probable that the banded and bandless are of different species and as such have a different germinal stability. That the two are of different species is proven by the fact that they would not cross. This is true whether the mating is between the Cebu forms or between the Manila forms. In addition to their failure to cross, the banded and bandless differ in many other respects that would place them under separate species. The banded is more viable, more prolific, more active, and lives longer than the bandless. The male of the banded is provided with a comb at the inner surface of the distal end of the first tarsal segment, while the male of the bandless has none (Plate 1, figs. 5 and 6).

Only the bandless form will be discussed thoroughly in as much as this is the one that gave rise to mutations. It cannot be stated for sure at present whether or not the Cebu and Manila bandless are of the same species, but it is most likely that they are for they and their mutants cross and produce fertile offspring. Moreover, their external appearances are exactly the same and the males of both do not possess a comb at the proleg. These forms are doubtless different from *Drosophila melanogaster* used by Morgan.

MUTANTS FROM THE BANDLESS CEBU WILD

The mutations that have their origin from the bandless Cebu wild are rose-eye, which was found to be sex-linked, and vestigial wing, which was found to be autosomal. There were several other variations observed from this stock but they did not breed true, due perhaps to the fact that they are somatic variations only, and therefore are not hereditary. Several variations found might be heritable, but due to their weakness and the fact that they are represented by one or two individuals only, their genetic behavior could not be studied.

THE "ROSE-EYE" MUTATION

After about four months of mass mating the bandless Cebu wild fly, there was observed for the first time May 8, 1924, a male fly with light red eyes to which was given the name "rose." A few days later more rose males were found, but no females. The absence of females among the first mutants suggests right away that this mutation is sex-linked. Morgan (1910) found similar phenomenon when he discovered the white-eye, a sex-linked mutation in *Drosophila melanogaster*. Whether or not this eye mutation is the same as the eosin or vermilion of Morgan (1911, 1912) or cherry of Safir (1913) could not definitely be ascertained, for no other sex-linked character was discovered to establish its true identity. However, I believe that it is not eosin, because rose is darker in shade and there is practically no difference in the eye color of male and female, nor of the homozygous and heterozygous individuals as in the case of eosin (Morgan and Bridges, 1916). It is not vermilion, because this rose mutation is lighter in shade than vermilion. It is probable that this is identical with cherry.

Rose-eye (Plate 2, fig. 2) is very noticeable among individuals that have just emerged from the pupal cases. The color changes to a darker shade as the fly grows older, but it never becomes as dark as the red-eye of the wild. The typical dark spot that is present at the center of the red-eye is absent in rose-eye. To insure proper classification, the flies should be examined when young, about a day or two after emerging from the pupal cases, otherwise some difficulties may be encountered. One who is experienced, however, will have no difficulty in distinguishing the rose from the wild no matter how old the flies may become. Rose flies in their pupal stage can be detected from the wild in having very light rose eyes, which can be seen through the transparent pupal cases.

So far as could be detected, rose mutation affects the eye color only, and as the breeding results show, there seems to be little effect upon the viability of the individual carrying the mutation.

In order to study the genetic behavior of the rose mutation, two types of mating were made with the wild. Rose females were mated with wild males and their reciprocal cross. Both types of matings were carried to the F_2 generation. Several series were made of each cross to insure proper results.

Table 1 shows the F_1 obtained by mating rose females with wild or red males. It will be noted that all females are red-eyed while all the males are rose-eyed. In a total of 11,022 F_1 flies, there are 5,678 of the former to 5,324 of the latter. This is exactly what would be expected if rose-eye is a sex-linked character and recessive to its allelomorph red-eye.

The F_1 of the above cross were mated together en masse and the result is shown in Table 2. There are in the F_2 both red and rose females as well as red and rose males in about equal numbers as would be expected. In a total of 18,859 F_2 flies, there are 4,886 red-eyed females, 4,883 rose-eyed females, 4,559 red-eyed males, and 4,531 rose-eyed males.

TABLE 1.—*F_1 obtained by mating rose-eyed females with red-eyed males.*

Series.	Red females.	Rose males.
1	343	232
2	756	670
3	266	266
4	134	133
5	719	721
6	678	692
7	1,566	1,396
8	169	179
9	523	531
10	524	504
Total	5,678	5,324

TABLE 2.—*F_2 obtained by mating together the F_1 red females and rose males.*

Series.	Females.		Males.	
	Red.	Rose.	Red.	Rose.
1	531	483	287	300
2	1,031	1,020	1,012	1,006
3	90	145	86	85
4	73	76	66	68
5	288	290	291	286
6	328	256	301	270
7	1,897	1,949	1,929	1,868
8	115	130	113	134
9	175	195	161	185
10	355	339	313	329
Total	4,886	4,883	4,559	4,531

A reciprocal cross was made by mating red-eyed females with rose-eyed males. As may be seen in Table 3, all the F_1 flies,

whether males or females, are red-eyed. In a total of 3,868 F_1 flies, 1,960 are males and 1,908 are females. The F_1 were mated inter se so as to produce F_2, and the result is shown in Table 4. All the F_2 females are red-eyed while the males are of two kinds, one half are red-eyed and the other half are rose-eyed. In a total of 1,784 F_2 flies, there are 841 red females, 469 red males, and 474 rose males.

The results in these two reciprocal crosses clearly indicate that "rose-eye" is a sex-linked character recessive to "red-eye."

TABLE 3.—*F_1 obtained by mating red-eyed females with rose-eyed males.*

Series.	Red females.	Red males.
1	613	615
2	108	102
3	198	215
4	147	159
5	146	127
6	134	112
7	97	92
8	120	90
9	259	274
10	28	20
11	110	102
Total	1,960	1,908

TABLE 4.—*F_2 obtained by mating together the F_1 red females and red males.*

Series.	Red females.	Males.	
		Red.	Rose.
1	239	143	123
2	32	18	14
3	270	150	169
4	27	10	22
5	60	37	29
6	31	12	21
7	63	32	27
8	119	67	69
Total	841	469	474

THE "VESTIGIAL WING" MUTATION

This is the second mutation that appeared from the bandless Cebu wild flies. It was first reported by Miss C. Antonio, September 23, 1925, and a few days later by Miss N. Castro. That the same mutation was discovered simultaneously by these two

students is explained by the fact that the Cebu wild stock they used came from the same source. When it first appeared it was called "wingless," but later it was changed to "vestigial wing" because it resembles the one described by Morgan (1919) under the same term. The wings are very much reduced and appear like a mere vestige in most individuals, although longer in others. In no case, however, were individuals found with wings that are even half as long as the normal. The balancers are also much reduced in length, the terminal segment suffering the greatest reduction (Plate 3, fig. 1).

The genetic behavior of vestigial wing was studied by mating with the wild form. Table 5 gives the results obtained in the F_1 and F_2 of the two reciprocal crosses. As may be noted, the F_1 are normal-winged in both crosses, thus showing that vestigial is an autosomal recessive to normal wing. The F_2 in both reciprocal crosses gives the typical Mendelian ratio irrespective of sex. In a total of 1,438 F_2 flies, there are 1,079 normal-winged to 359 vestigial winged or a ratio that is very close to 3:1.

TABLE 5.—*F_1 and F_2 obtained in both reciprocal crosses involving vestigial and normal wing.*

Type of mating.	F_1 normal.		F_2.	
	Female.	Male.	Normal.	Vestigial.
Normal ♀ × vestigial ♂	23	21	651	207
Vestigial ♀ × normal ♂	42	47	428	152
Total	65	68	1,079	359

MUTATIONS FROM THE BANDLESS MANILA WILD

The mutations that were found from the bandless Manila wild are "eyeless" and "purple-eyed." Both of these behave as simple Mendelian mutations recessive to their normal allelomorphs. There are other mutations that owe their origin to the bandless Manila wild, but these will be reported later in another paper because their exact genetic behavior is still being studied.

THE "EYELESS" MUTATION

This mutation was first observed in the bandless Manila wild June 22, 1926. The first flies found were of both sexes and were thought to be "white-eyed," but on closer examination proved to be "eyeless." This same mutation was also reported by Morgan (1914) as a fourth chromosome mutation.

The eyeless individual has a very small head due to the failure of the ommatidia to develop. Likewise, the ocelli are absent. The area that used to be occupied by the ommatidia is very much roughened with irregularly scattered hairs and bristles. There is, however, a great variation in the manifestations of this eyeless mutation. Most of the individuals are totally eyeless (Plate 3, fig. 2), but there are those that possess small eyes on the right side only and none on the left side (Plate 3, fig. 4); those with small eyes on the left side only and none on the right side (Plate 3, fig. 3); and those with small eyes on both sides (Plate 4, fig. 1). These small eyes when present are mostly sessiled or flat on the head, but there are cases where the eyes are much elevated giving them a stalked appearance (Plate 4, figs. 2 and 3). Several flies were found that possessed two small eyes on one side and only one on the other side (Plate 4, fig. 4). The eyes whenever present vary from microscopic proportions to a size that could easily be detected without the use of a lens. Some have their eyes anteriorly placed, while others have their eyes at the posterior margin of the head. In case eyes are present on both sides, they are rarely equal in size, shape, and position.

Eyeless individuals are the most numerous, the next are the right-eyed, then follows the left-eyed, and the least numerous are those with eyes on both sides. The difference in number between right- and left-eyed is so small that they can be considered equal. In a total of 3,114 flies, 2,507 are totally eyeless, 283 are right-eyed, 267 are left-eyed, and 57 have eyes on both sides. This gives 80.51 per cent, 9.09 per cent, 8.58 per cent, and 1.82 per cent, respectively (See Table 6).

TABLE 6.—*Count of the eyeless stock showing the number and percentage of different eye variations.*

	Eyeless.	Right-eyed.	Left-eyed.	Two-eyed.	Total.
Number	2,507	283	267	57	3,114
Percentage	80.51	9.09	8.58	1.82	100

Count of the eyeless stock also shows that the actual number as well as the percentage of eyed forms is higher in females than in males. This is true in the right-eyed, left-eyed, or two-eyed (see Table 7). Among the females there are 11.22 per cent right-eyed, 10.08 per cent left-eyed, and 2.44 per cent two-eyed,

while among the males there are 6.54 per cent right-eyed, 6.82 per cent left-eyed, and 1.11 per cent two-eyed, respectively.

TABLE 7.—*Showing the relative number and percentage of the different forms of eyeless in males and females.*

Forms of eyes.	Females.		Males.	
	Number.	Percentage.	Number.	Percentage.
Eyeless	1,277	76.19	1,230	85.53
Right-eyed	189	11.22	94	6.54
Left-eyed	169	10.08	98	6.82
Two-eyed	41	2.44	16	1.11
Total	1,676	100.00	1,438	100.00

According to our unpublished results these different variations exhibited by the eyeless stock are not hereditary. They are probably somatic variations in the manifestation of the eyeless gene.

Crosses of the eyeless with normal eyed invariably give F_1 that are normal eyed, showing that it is recessive to normal eye. This is true in both reciprocal crosses. The F_1 when mated together give eyeless and normal-eyed flies in the ordinary simple Mendelian fashion as shown in Table 8. In a total of 7,896 F_2 flies obtained in both reciprocal crosses 5,951 are normal-eyed and 1,945 are eyeless, representing a ratio of 3 of the former to 1 of the latter.

TABLE 8.—*F_1 and F_2 obtained in both reciprocal crosses involving eyeless and eyed.*

Type of mating.	F_1 eyed.		F_2.	
	Female.	Male.	Red.	Purple.
Eyeless ♀ × eyed ♂	1,241	1,123	2,803	918
Eyeless ♂ × eyed ♀	1,347	1,203	3,148	1,027
Total	2,588	2,326	5,951	1,945

"PURPLE-EYE" MUTATION

This mutation appeared twice in the bandless Manila wild stock. The first appearance was noted July 7, 1925, among a batch of old flies. Due to the brownish tinge of the eyes of these flies, they were temporarily called "brown-eyed." No pure culture was produced when they first appeared for they died

shortly after they were found. The second time this mutation appeared was August 26, 1926. A pure culture was raised at this time and it was noted that the change in the eye color as the flies grew older was similar to the "purple" of Morgan (1919). For this reason the name was changed from brown to purple. When the flies newly emerge from the pupal cases the color of the eyes is very light purple (Plate 2, fig. 3), and this turns darker until on the third or fourth day the color is very dark purple with a brownish tinge (Plate 2, fig. 5). This is especially true in very old flies. The true purple shade is exhibited by flies that are about a day or two old (Plate 2, fig. 4).

Genetic tests of "purple-eye" show that it is an autosomal mutation recessive to "red-eye." Table 9 shows the result of the two reciprocal crosses. The F_1 are all red-eyed while the F_2 are of two kinds, red-eyed and purple-eyed. Among 9,938 F_2 flies in both crosses, there are 7,368 red-eyed to 2,570 purple-eyed or a ratio that is close to 3:1.

TABLE 9.—*F_1 and F_2 obtained in both reciprocal crosses involving purple and red.*

Type of mating.	F_1 red.		F_2.	
	Female.	Male.	Red.	Purple.
Purple ♀ × red ♂	1,920	1,710	4,296	1,540
Red ♀ × purple ♂	1,300	1,218	3,072	1,030
Total	3,220	2,928	7,368	2,570

CONCLUSIONS

1. Of the two Philippine forms used in this experiment, the bandless gives rise to mutations while the banded does not.

2. The bandless and banded are undoubtedly of two different species for they do not cross and have a different external appearance.

3. The bandless Cebu and Manila wild may be of the same species for they look alike and they and their mutants produce fertile offspring when crossed.

4. Most of the mutations found are autosomal for out of the four reported, three are autosomal and only one is sex-linked.

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ILLUSTRATIONS

PLATE 1

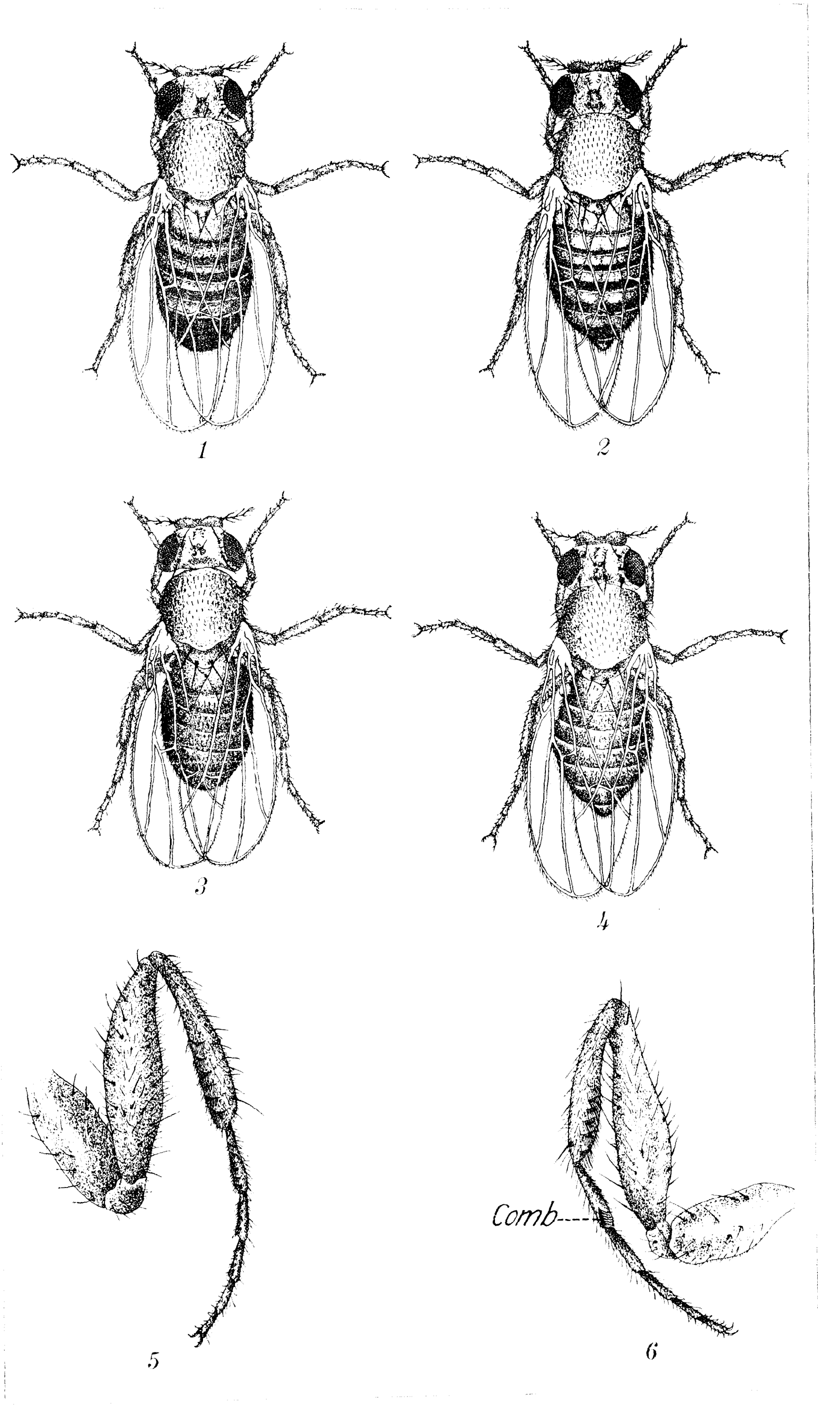
FIG. 1. Banded wild male.
2. Banded wild female.
3. Bandless wild male.
4. Bandless wild female.
5. Left proleg of the bandless wild male showing the complete absence of comb.
6. Right proleg of the banded wild male showing the presence of comb.

PLATE 2

FIG. 1. Wild fly showing the red eye color.
2. Rose mutant.
3. Young purple just emerged from the pupal case.
4. Medium purple about a day or two old.
5. Old purple about four days old.

PLATE 3

FIG. 1. Vestigial mutant with wings almost completely gone.
2. Totally eyeless.
3. Right-eyed variation of eyeless mutation.
4. Left-eyed variation of eyeless mutation.
5. Two-eyed variation of eyeless mutation.
6. Right-eyed, but the eye is stalked.
7. Two-eyed, but the eyes are stalked.
8. Three-eyed; two of the eyes are on the left side and one is on the right side.



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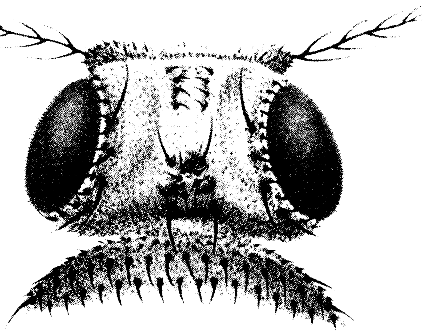

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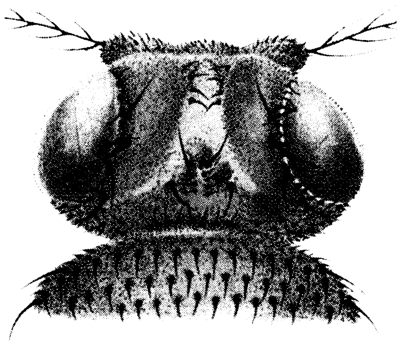

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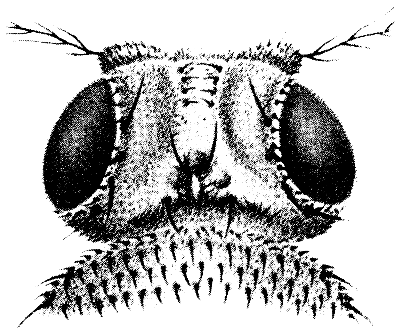

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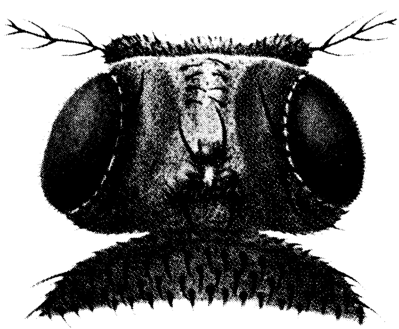

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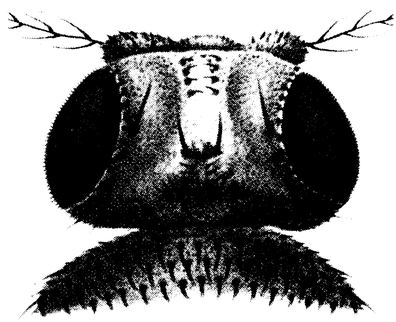

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PLATE 2.

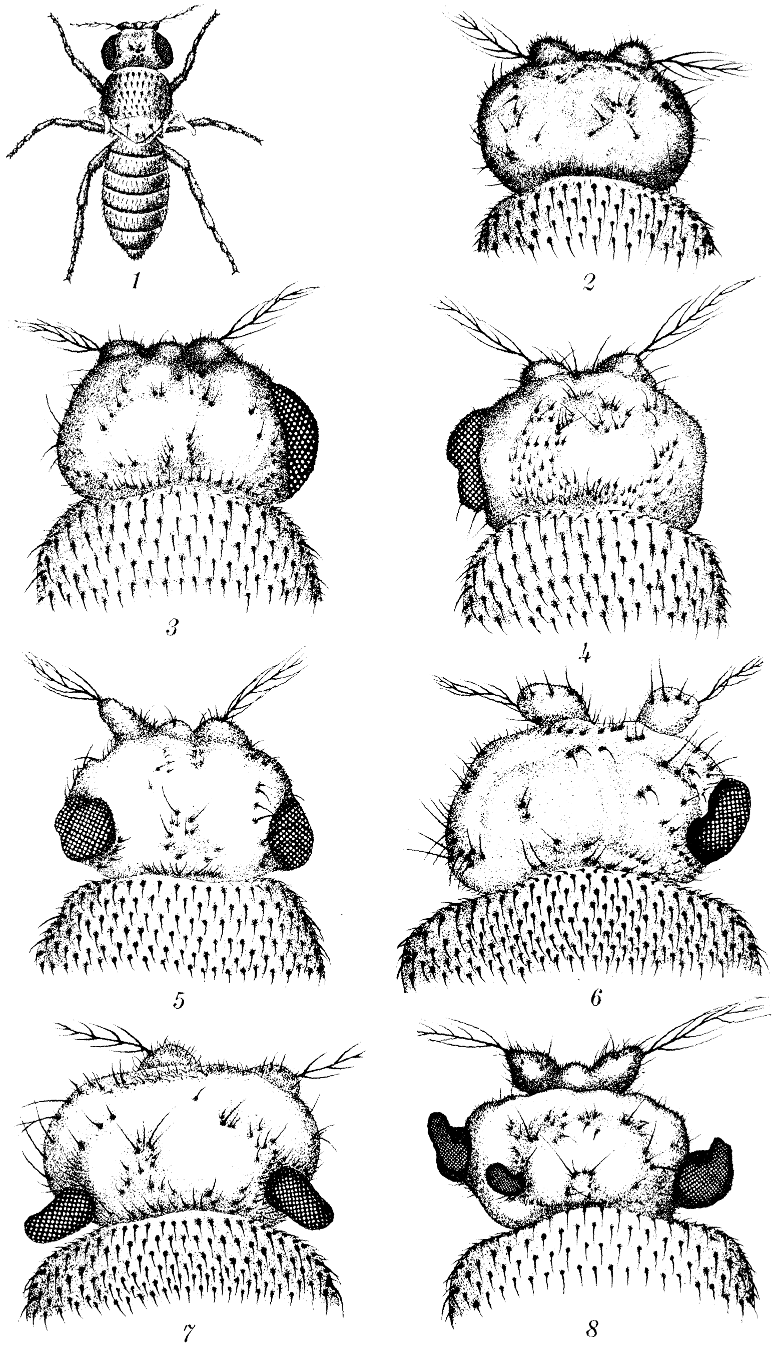

PLATE 3.

DETERIORATION OF HYPOCHLORITES

By R. H. AGUILAR
Of the Bureau of Science, Manila

THREE TEXT FIGURES

"Bleaching powder," or "calcium hypochlorite," is extensively used as a disinfectant. The chemical is cheap and relatively much easier to handle than other disinfectants of similar properties. However, it possesses the inconvenience of losing its activity on storage. Another useful disinfectant is "sodium hypochlorite." Like calcium hypochlorite it also deteriorates on standing.

"Bleaching powder" is mainly used in the disinfection of swimming pools and municipal water supplies; "sodium hypochlorite" is used in the disinfection of domestic drinking waters, domestic utensils, hospital wares, and clinical instruments.

The substances used in these tests for purposes of observation were prepared in the laboratory from commercial slaked lime and from solutions of commercial sodium hydroxide, treated with chlorine gas until the desired strengths were obtained. A solution of sodium hypochlorite prepared from chemically pure sodium hydroxide and distilled water is also included in the tests for purposes of comparison.

TEST SAMPLES

The chlorinated lime was divided into two portions. One portion was packed in four 10-gallon capacity wooden boxes, covered with asphaltum inside and out. The boxes were practically moisture proof at the time of packing. The other portion was placed in 7 cubic centimeter amber-colored glass vials, each tightly stoppered with rubber stoppers. Two of the wooden cases and several vials were stored in a refrigerator wherein the temperature oscillated between 8° C. and 12° C. The other two wooden boxes and the rest of the vials were stored in the laboratory at an average temperature of 29° C. In the same manner, the sodium hypochlorite solution was distributed in several 200 cubic centimeter and 700 cubic centimeter dark-colored bottles. The bottles were also divided into two lots;

one lot was stored in the refrigerator, and the other lot in the laboratory. The test samples were analyzed every month for their content of available chlorine following the standard methods of analysis.[1]

DISCUSSION OF RESULTS

The results of tests are shown in Tables 1 and 2. The same results are graphically represented in figs. 1 and 2.

TABLE 1.—*Deterioration of chlorinated lime on storage.*

Storage period.	Stored in wood boxes of 10-gallon capacity.		Stored in 7 cc colored vials, tightly stoppered.	
	In the refrigerator.	In the laboratory.	In the refrigerator.	In the laboratory.
Original strength	29.52	29.52	29.53	29.53
One month	29.11	22.32	29.20	25.39
Two months	28.70	16.40	28.92	21.65
Three months	28.11	11.26	28.70	18.03
Four months	27.46	6.96	28.25	15.00
Five months	27.10	4.82	27.99	11.93
Six months	26.71	2.90	27.50	9.82
Seven months	26.41	1.91	27.15	7.23
Eight months	25.96	1.08	27.00	5.97
Nine months	25.66	0.67	26.63	4.43
Ten months	25.00	0.36	26.20	3.26
Eleven months	24.70	0.35	26.00	2.03
Twelve months	24.31	0.13	25.60	1.20
Thirteen months	23.92	0.07	25.35	0.95
Fourteen months	23.30	0.02	25.13	0.12

The curves may be considered as the theoretical curves that would be obtained under ideal uniform conditions. The points show the actual values of monthly deterioration. Their deviation from the curves may be interpreted as indicating variation of temperatures, which is relatively little, variation of moisture and other atmospheric conditions.

The chlorinated lime stored in wooden boxes appears to have deteriorated faster than the same material stored in colored vials. This is true not only of samples stored in the laboratory, but also of samples stored in the refrigerator. These results seem to agree to a certain extent with those obtained by McDonnell and Hart[2] who indicated that chlorinated lime stored

[1] Scott, W. W., Standard Methods of Chemical Analysis. 4th ed., D. Van Nostrand Co., New York 1 (1925) 151 and 154.

[2] U. S. Dept. of Agr. Bull. 1389 (1926) 13.

in fiber containers deteriorated relatively faster than the same material stored in glass bottles.

There is, however, one important difference between the results obtained by McDonnell and Hart,[3] who worked under conditions prevailing in the United States, and the results obtained in this work. According to them, the available chlorine in most samples of chlorinated lime packed in containers of the usual commercial type decreased fairly regularly during storage; the decrease of available chlorine in this work under ordinary Philippine conditions is fairly rapid at first, then it becomes slower as the quantity of available chlorine is smaller. This is true of samples stored in the laboratory. The samples stored in the refrigerator decreased in strength almost regularly within the fifteen months' storage.

TABLE 2.—*Deterioration of sodium hypochlorite solution on storage.*

Storage period.	Prepared from solution of chemically pure sodium hydrate in distilled water.		Prepared from solution of commercial sodium hydrate in tap water.	
	In the refrigerator.	In the laboratory.	In the refrigerator.	In the laboratory.
Original strength	4.49	4.49	4.47	4.47
One month	4.46	4.22	4.45	4.25
Two months	4.43	4.08	4.44	4.03
Three months	4.42	3.88	4.44	3.80
Four months	4.41	3.76	4.41	3.59
Five months	4.38	3.53	4.39	3.41
Six months	4.36	3.45	4.37	3.25
Seven months	4.34	3.30	4.35	3.07
Eight months	4.31	3.12	4.34	2.93
Nine months	4.30	3.01	4.30	2.74
Ten months	4.26	2.96	4.27	2.59
Eleven months	4.22	2.90	4.23	2.47
Twelve months	4.20	2.81	4.20	2.34
Thirteen months	4.15	2.73	4.15	2.25
Fourteen months	4.11	2.68	4.11	2.16
Fifteen months	4.07	2.64	4.07	2.07
Sixteen months	4.05	2.60	4.03	1.98

Macculoch[4] has demonstrated that a sample of bleaching powder manufactured in England contained 35 per cent available chlorine; on reaching Madras it was reduced to 20.04 per cent, and six weeks afterwards, it contained only 12.52 per cent, a reduction of 37 per cent in six weeks under tropical con-

[3] Loc. cit.
[4] Journ. Soc. Chem. Ind. No. 19 40 (1921) 240T.

ditions. This result agrees very well with that obtained in this work from chlorinated lime packed in wooden barrels and stored in the laboratory (see fig. 1). In 1.4 months (6 weeks), there was a decrease of available chlorine from 20 per cent to 12.4 per cent, or a reduction of 37 per cent.

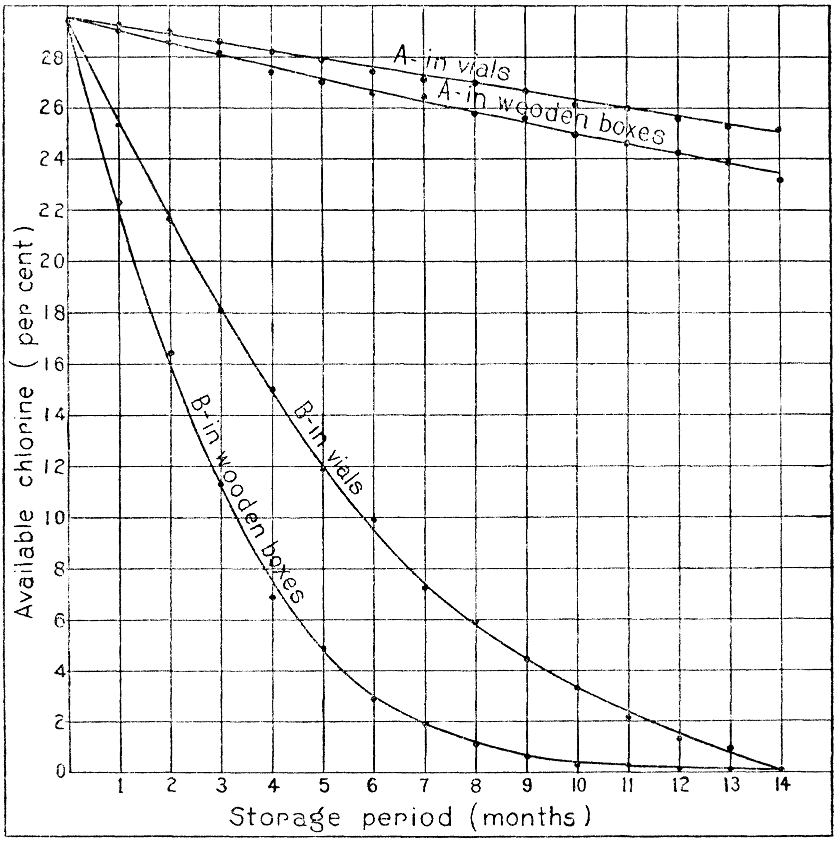

FIG. 1. Deterioration curves of chlorinated lime. A, stored in the refrigerator at 8 to 12° C B, stored in the laboratory, average temperature 29° C.

It is to be noted in this connection, that the samples packed in wooden boxes were found moist at the end of the test, indicating absorption of moisture, in spite of the precautions taken by covering the boxes with asphalt inside and out. This moist condition of the samples, possibly, has been one of the causes of the relatively more rapid deterioration of the chlorinated lime kept in the wooden barrels, as compared with that kept in glass vials.

In regard to the deterioration of sodium hypochlorite, or chlorinated soda, it is also apparent from Table 2 and fig. 2 that the rate of loss of available chlorine is greater at higher concentration and less at lower concentration. It is also apparent that the sodium hypochlorite solution prepared from tap water and commercial sodium hydrate, deteriorated faster than the sodium hypochlorite prepared from chemically pure sodium hydrate and distilled water, indicating that the rate of decomposition is affected by the impurities contained in the samples. In the refrigerator, however (at temperatures 8° C. to 12° C.), the rates of deterioration of the two solutions were practically the same.

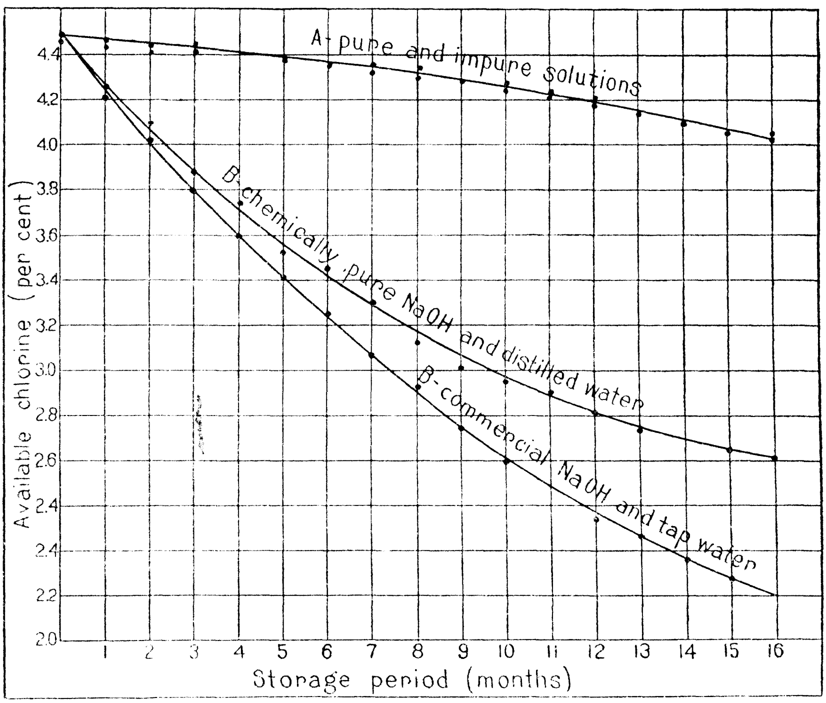

FIG. 2. Deterioration curves of sodium hypochlorite solutions. A, stored in the refrigerator at 8 to 12° C. B, stored in the laboratory, average temperature, 29° C.

Tests made of the content of available chlorine of chlorinated soda, or "hychlorite," [5] under conditions prevailing in temperate regions, indicated a rate of loss varying from 12 per cent to 24.8 per cent per year. The original chlorine content of the

[5] Am. Med. Assoc. Chem. Lab. Reports 11 (1918) 81.

solutions were 3.85 per cent and 4.18 per cent. In this work, starting from a concentration of 4.48 per cent, the losses after twelve months were 37.4 per cent and 47.6 per cent of pure and impure samples, respectively.

That the losses at higher concentration are greater than those at lower concentration has been already reported by Wells,[6] who stated that in three solutions, having original concentrations of available chlorine of 8.42, 11.32, and 13.28 per cent, after over three months the concentrations came down to practically 6 per cent for the three solutions, the loss of available chlorine being 29, 47, and 55 per cent, respectively.

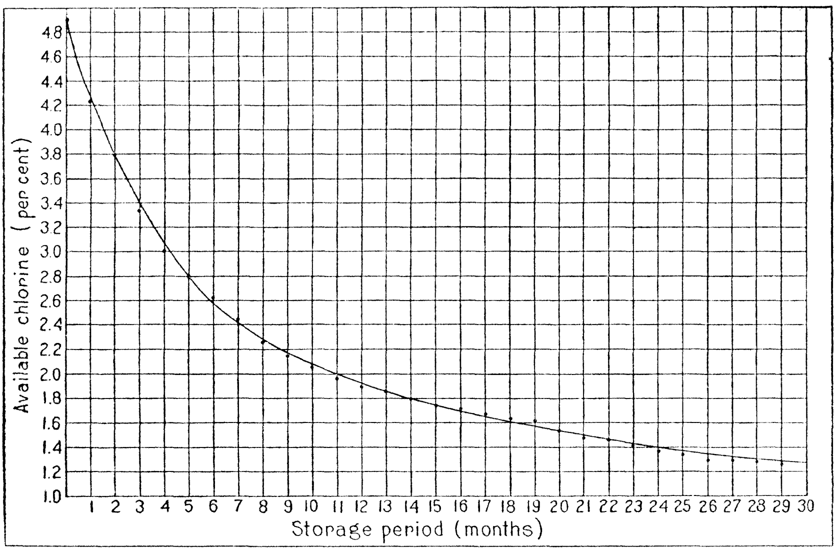

FIG. 3. Deterioration curve of commercial sodium hypochlorite solution manufactured in the Philippines.

As additional data corroborating the results herein reported, it is believed, that the observations[7] made at the Bureau of Science at the request of a local manufacturer, on the deterioration of a sample of commercial sodium hypochlorite, would be of interest. The results comprising a period of thirty months are plotted in fig. 3. It may be observed that the general aspect of the deterioration curve is similar to the deterioration curves shown in fig. 2.

[6] Am. Journ. of Pharm. **98** (1926) 405.

[7] The greater portion of the observations were made by Lourdes Ocampo, chemist, Bureau of Science.

Tests have also been made on the rate of deterioration of the hypochlorite solution contained in loosely stoppered bottles. The results obtained indicate that solution placed in loosely stoppered bottles, under identical conditions, deteriorates at practically the same rates as solutions of the same strength kept in tightly stoppered bottles.

Differences in the size of the bottles do not produce perceptible differences in the rates of deterioration.

SUMMARY

1. The deterioration of bleaching powder and sodium hypochlorite solution, under Philippine conditions, is not uniform and regular. It is more rapid at higher concentration, becoming slower at lower concentration.

2. Stored in a refrigerator at temperatures of 8° C. to 12° C. the monthly deterioration losses appear to be uniform and relatively small.

3. Commercial hypochlorite solutions deteriorate faster than chemically pure preparations of the same strength.

ILLUSTRATIONS

TEXT FIGURES

STUDIES ON EARLY LEPROSY IN CHILDREN OF LEPERS, II

REËXAMINATION OF CASES AFTER FIVE YEARS

By JOSÉ RODRIGUEZ

Of the Philippine Health Service
Chief, Eversley Childs Treatment Station, Cebu, Cebu

In 1922, Gomez, Avellana and Nicolas[1] made a survey of three hundred eight children born of leper parents who were then living in the Culion Leper Colony. In the latter part of 1924, I examined[2] three hundred ninety-eight of these children and endeavored to secure additional data bearing on the incidence of leprosy as to age and sex among them; the factors influencing transmission during intrauterine life, infancy, and early childhood; the nature of the initial lesion; and the effects of early and delayed separation of such children from leper surroundings.

Of the three hundred ninety-eight children living at Culion as of December 31, 1924, fifty-nine (14.8 per cent) were found to have become "confirmed" cases of leprosy (bacteriologically positive); eleven (2.8 per cent) had leprotic lesions, which however were bacteriologically negative ("clinical lepers" or "closed" cases); ninety-seven (24.4 per cent) showed signs "suspicious" of leprosy; and two hundred thirty-one (58 per cent) had no visible lesions and were considered "nonlepers." Thirty-two were living in the Negative Children's Home situated at Balala, the nonleper settlement; the rest were living with their parents or leper guardians in the colony itself. Of the latter, fifty-three were less than 1 year of age.

Previous to the 1924 survey, only a few of the children born in the colony of leper parents were being transferred to the Negative Children's Home. Separation after birth was attempted at the beginning, but most of the infants thus segregated died, and the parents refused to give up their children

[1] Philip. Journ. Sci. 21 (1922) 233–256.

[2] Rodriguez, Philip. Journ. Sci. 31 (1926) 115–145.

until they were old enough to be weaned. Thereafter, only some of the older children, from 6 months to 11 years of age, were isolated. They were carefully examined before admission, and only those that showed no suspicious signs were admitted.

No child above the age of 6 months was allowed to be taken away from the Colony unless it had been placed under observation in the Negative Children's Home for four consecutive years and had not shown any suspicious lesions of leprosy during that time.

Up to the time of the 1924 survey, one hundred twenty-three children had been admitted to this home. Of this number, 23 per cent developed leprosy during the period of isolation and were returned to the colony as lepers. Among those who were not isolated in the home and had remained continuously with their parents, only 11.5 per cent developed leprosy. Although direct comparison of these two groups is not possible due to reasons explained in my first article, it seems quite evident that delayed segregation of the children of lepers did not prevent the development of the disease in many of the Culion children. In order to be effective, isolation has to be from the time of birth or as shortly thereafter as possible. At any rate, it must be accomplished before the sixth month. Furthermore, it seems that the kind of care and the adequacy of food have a more important bearing on the development of leprosy than segregation per se, if this is delayed beyond six months.

After the 1924 survey, important changes in the management of Culion children took place. Following the order of superior authorities, all children in the colony above the age of 2 years, including those living at home, were sent to Manila during the latter part of 1925 and the first months of 1926, and placed under the care of the Public Welfare Commissioner. Moreover, it was implicitly ordered that all the children who were not positive bacteriologically were to be brought to Manila, and as a result, many bacteriologically negative but suspicious and clinical lepers were included among those taken to Manila.

A few months after the transfer of these children was effected, a severe epidemic of dysentery occurred among them at Manila. By April 30, 1926, seventy-one of the two hundred eighty-nine children transferred had died. Partly on account of this epidemic and partly because many of the parents at Culion were unwilling to give up their children, a large number

of the transferred children were discharged and given to reliable relatives and guardians outside the colony, with the condition that they were to be presented to the local health officers for examination every three months. As a matter of fact, many of them were never examined after discharge, and this in spite of the fact that some of them were probably suspicious lepers and a few even considered clinical lepers at the time of discharge.

The older children from Culion are now living at Welfareville in Mandaloyon, Rizal, in the suburbs of Manila. There were sixty-eight girls and ninety-six boys there by December 31, 1929. Of these, my records show that only ninety were examined in the 1924 survey. They are housed in a clean and well-ventilated building and receive the best of care and attention. Practically all of them go to school and the older ones are taught some trade or business so that they may be able to shift for themselves when they become of age.

At Culion, the older Negative Children's Home has been remodelled and converted into a nursery. The staff has been also much improved. The present policy is to remove to the nursery at birth or as shortly thereafter as possible all children born in the colony. When the children reach the age of 2 years, they are sent to Manila and placed at Welfareville.

Exactly five years after my first survey, or during October, November, and December, 1929, I endeavored to trace as many of the three hundred ninety-eight children examined during the first survey as possible. Those remaining at Welfareville, at San Lazaro, and at Culion were reëxamined. Letters were sent to trace those who had been discharged from Welfareville and from the Negative Children's Home. Records at Welfareville, San Lazaro, and Culion bearing on these children were freely consulted.

PRESENT SURVEY

Of the three hundred ninety-eight children examined in 1924, I could no longer trace and identify sixty-two of the youngest, due to destruction and irrevocable loss of part of my records during an absence from the Philippines in 1926.

As of December 31, 1929, of the three hundred thirty-six whose records could be traced, fifty had been rendered negative and paroled after having been positive (five of these were at Welfareville) ; thirty-one were still lepers living either at Culion or San Lazaro; fifty-six had died; ninety were at Welfareville

(including the five paroled ex-lepers); one hundred six had been discharged and given to nonleper relatives and guardians; one was at Culion, a helpless paralytic but nonleper; one was at Santol Tuberculosis Sanatorium; and one was being kept at San Lazaro as a clinical leper.

Only forty-nine of the one hundred six discharged children could be located by writing to their guardians or relatives and only three of them could be examined by the writer. These three were found nonlepers, but two others who had gone to Culion to visit their parents were found "positive lepers" by the Culion staff.

At Welfareville, five of the children were "negative" or "arrested" ex-lepers; thirteen still had suspicious signs of the disease; four showed acnotenic lesions, although they have never been found positive and the lesions had remained stationary for over two years; and sixty-eight were considered nonlepers.

POSITIVE LEPERS

In spite of certain objectionable features, the original classification of the Culion children into "positive lepers," "clinical lepers," "suspicious lepers," and "nonlepers," adopted by Gomez, Avellana, and Nicolas has been followed in the present survey to make it possible to compare the present results with previous findings. Including those discovered in 1922, and dealing only with those born previous to December 31, 1924, eighty-five are known to have developed leprosy, the diagnosis being confirmed in each instance by bacteriological examination. Lara and Nicolas [3] reported three additional cases that were born after 1924 and are therefore not included in the eighty-five cases here being reported.

Four of the eighty-five cases who became lepers died, fifty were paroled after all signs of activity had disappeared and repeated bacteriological examinations had proved negative for six months or more, and thirty-one were still segregated, either at Culion or at San Lazaro. Four of the latter, however, have been declared "quiescent" and were to be paroled in due time; the rest had active signs of the disease.

The number becoming positive from year to year is given in Table 1.

[3] Journ. Philip. Is. Med. Assoc. 9 (1929) 321–326.

TABLE 1.—*Showing number of positive cases discovered yearly from 1922 to 1929 inclusive.*

Year	Number found positive.
1922 and previous	24
1923	22
1924	16
1925	14
1926	2
1927	3
1928	2
1929	2
Total	85

De Vera [4] reports that no new case of leprosy has been discovered among the children remaining at Culion after 1927, so that all the four positive cases discovered in 1928 and 1929 came from Welfareville.

There is a sudden drop in the number of cases becoming positive after 1925. The possible causes for this diminution are: (1) Fewer cases under observation due to discharge of many of the children, including some suspicious cases and clinical lepers; (2) intensive treatment of "clinical lepers;" (3) the transfer of the older children to Manila; and, most important of all, (4) the early segregation of the younger ones at the nursery at Balala.

As to sex, forty-four of those who have become lepers were males and forty-one were females. The proportion between males and females in the whole group whose records can be traced is one hundred fifty-nine boys and one hundred seventy-seven girls. The relative proportion of those becoming positive among the boys is somewhat higher (28 per cent) than those becoming lepers among the girls (23 per cent).

The average age at which children were found clinically and bacteriologically positive among the fifty-nine positive lepers in the 1924 survey was 5 years 9 months. The average age of the twenty-six lepers discovered after 1924 was 7 years 2 months.

It is still not generally recognized that it is possible to make a diagnosis of leprosy before the lesions become bacteriologically positive. In ten of the eighty-five cases that became positive, undoubted clinical signs of leprosy ("clinical lepers") were seen

[4] Journ. Philip. Is. Med. Assoc. 10 (1930) 457–469.

from three months to four years before the presence of bacilli was finally demonstrated on the skin or nasal membranes. In three, fourteen, and four other patients, suspicious lesions ("suspected lepers") existed two, three, and four years, respectively, before the cases were found positive bacteriologically. In four children, the suspicious lesions were present for two years, then disappeared for one year, and then returned, becoming bacteriologically positive. In two other cases, the suspicious signs which persisted unchanged for two years finally became clinically leprotic but bacteriologically negative and remained thus for one more year, at the end of which period the lesions, but not the nasal mucosa, showed the presence of *Mycobacterium lepræ,* making a total of thirty-seven cases where suspicious or definite lesions of leprosy were detected from a few months to four years before the presence of the organism could be demonstrated.

On the other hand, there were twenty-four children who had been periodically examined for periods ranging from one to four years, with not a single child showing the least suspicious symptom or blemish whatever; quite suddenly, typical leprotic lesions appeared, and these were found positive bacteriologically at the first examination.

The typical leprotic lesions and the usual sites of predilection have already been fully discribed in the first survey and will not be discussed again in this paper.

However, it may be instructive to know whether or not the suspected patches actually developed into active leprotic lesions. Accurate data regarding this point are available for only eight clinical lepers and thirty suspected lepers who subsequently developed bacteriologically positive lesions. Among the clinical lepers, the same lesion clinically diagnosed as leprotic at the onset became "positive" in seven cases; in the remaining case, a new lesion appeared and this was the first to become positive bacteriologically.

In the thirty children who presented suspicious macules, the same suspected lesions eventually were found positive in twenty-four cases; in the rest, the positive smears were obtained from other sites, either from the ear lobes or from new patches. In no case were smears found positive in the nasal mucosa before the organisms could be demonstrated in the skin.

CLINICAL LEPERS

Fifty-one cases showed undoubted leprotic lesions consisting of typical pale or reddish macules presenting definite anæsthesia,

and accompanied by subsidiary signs of leprosy such as thickened cutaneous nerves, enlarged lymphatic glands, anhydrosis, ichthyosis, etc. However, repeated bacteriological examinations of smears taken from various portions of the lesions as well as from the nasal mucosa were consistently negative, at least for some time. In ten cases such smears were finally found positive after a period ranging from three months to four years; the rest never reached the "positive" stage; that is, the organisms have never been demonstrated in the lesions or in the nasal mucous membrane. In these latter cases, the macules gradually faded with almost complete recovery from the anæsthesia in many of them. In others, all that remained were atrophied scars or acroteric lesions involving one or both of the upper extremities, which have remained unchanged for years. Such cases may probably be considered "arrested." The four clinical lepers living at Welfareville probably belong to this category.

Gomez and coworkers classified twenty children as clinical lepers in 1922. By the end of 1924, eight, or 40 per cent, had been declared positive or confirmed lepers. On the other hand, of the thirty-one cases that were classified as clinical lepers after 1924, only two progressed to the "positive" stage. It is believed that the marked reduction in the proportion of so-called clinical lepers who have developed bacteriologically positive lesions since 1924 is due largely to the antileprotic treatment. When a case is declared "clinically positive," intensive treatment including the so-called "plancha" method is invariably given by their physicians without waiting for the bacteriological examination to become positive.

SUSPICIOUS LEPERS

The so-called "suspicious" lesions need further elucidation. One of the commonest early manifestations of leprosy among the Culion children are the "pale macules," or the "depigmented patches," as others prefer to call them. These macules are generally irregular in shape (although the most usual shape is roughly oval), pale or fawn-colored, with non-elevated but fairly distinct borders, and with the surface free from scales. The size may vary from that of a rice grain to extensive areas covering a large portion of an extremity or the trunk. In older patches, perspiration is diminished or absent while the hair is scanty and deformed, or entirely absent.

In the Philippines, the pale macules of leprosy are frequently mistaken for *T. flava* by the laity and even by physicians. The

typical appearance of the macule, the lack of furfuraceous scales, and the distribution are so characteristic that after seeing a number of these lesions, confusion is hardly possible except in rare cases. If there is the least doubt, scrapings should be made and examined for the fungus. Even the attendants working in the Cebu Skin Dispensary are able to distinguish the typical pale macule of leprosy at a glance after seeing a score of early cases.

When anæsthesia is distinctly present, together with a thickening of the cutaneous nerve supplying the area, and the appearance of the macule is typical, a diagnosis of leprosy may be safely made, although the bacteriological examination may prove negative. Such cases were classified by Gomez and coworkers as "clinical lepers."

When the anæsthesia cannot be accurately determined as is usually the case in infants and young children, when the borders of the macules are not distinct, and particularly when the appearance is not typical, the lesion is diagnosed as "suspicious." Such lesions often have to be observed for months or even years before a definite diagnosis can be made. Due to the difficulty of proving the presence of anæsthesia in young children, there are naturally many more "suspicious" cases among them than among adults.

Among intelligent adult patients, and particularly where there are facilities for performing the proper laboratory examinations, including biopsy, there is hardly ever any need for this designation.

Another suspicious lesion, which to my knowledge has been described only in the Philippines, is a characteristic flushed, tense, and glistening appearance of the skin on the front of either one or both legs of children below the age of 2 years. As the child grows older, the involved skin becomes dry, harsh, and cracked, simulating very closely a moderately severe case of ichthyosis. I propose the designation of "Nicolas sign" for this condition, after Dr. Catalino Nicolas, the first clinician of Culion to notice it. All the children under my observation who developed this condition during infancy became lepers later on.

It is apparent that not all children temporarily classed as "suspicious" become lepers. However, the proportion becoming positive from suspicious cases is much higher than that developing from a group showing no suspicious lesions at all. For instance, only thirty-six children (12 per cent) developed de-

finite symptoms of leprosy from the group of two hundred six children classified as nonleprous by Gomez and coworkers, while fully 57 per cent became lepers in their suspicious group of fifty-eight children.

It has already been mentioned earlier in this paper that in eighteen cases, the suspicious lesions were detected three to four years before the presence of *M. lepræ* could be demonstrated in the lesions or in the nasal mucous membrane. This observation would seem to demonstrate that "suspicious" children of lepers should be kept under constant observation for at least four years. In fact, a longer observation period is probably necessary. Four of the children living at Welfareville at the end of 1929 showed suspicious lesions, which had been known to exist for at least seven years. At times, these lesions almost entirely disappeared only to reappear and become quite distinct again. Of course it is impossible to tell whether or not these suspicious lesions will ever become bacteriologically positive.

In going over the above data, the impression is obtained that the majority of Culion children have at one time or another shown either suspicious or definite signs of the disease. This is indeed the case. According to my records of the two hundred six children found nonleprous in 1922, to which I added thirty-three new cases in 1924, only eighty-five escaped from suspected or confirmed lesions of leprosy. Of this number, nineteen had died, twenty-six were at Welfareville, and forty had been discharged at the time of the present survey.

EFFECTS OF TREATMENT

The results of the antileprotic treatment among the Culion children who have become lepers has already been reported by other workers and need not be discussed further in this paper. In 1928, Nicolas and Roxas-Pineda[5] reported that among seventy leper children, most of whom were born at Culion, who were treated for periods ranging from ten months to five and one-half years, thirty-eight became negative or quiescent cases. Their paper discussed the relation of age and sex, kinds of drugs used, type and advancement of the disease and duration of treatment, to the results of the treatment. Lara and Nicolas reported the efficacy of the "plancha" or infiltration method of injecting the iodized esters of *Hydnocarpus wightiana* oil in six

[5] Journ. Philip. Is. Med. Assoc. 8 (1928) 314–316.

of these leper children. Four of them in the early stages became negative in one month, another became so after four months of treatment, while the only slightly more-advanced case required five months intensive treatment.

It has already been stated that fifty of these children have become quiescent cases through treatment. How many of these will continue to remain inactive permanently remains to be seen. According to available records, ten of these children have lived for some time at Welfareville, and of these, five have been found bacteriologically positive again. In three of them, there was a clinical reactivation, with appearance of new lesions.

It has also been noted earlier in this paper that vigorous treatment with antileprotic drugs has apparently diminished the number of clinical lepers who have become bacteriologically positive cases of leprosy since 1924.

There is still another important feature of the treatment, however, which has not yet been touched upon. Some workers have been advocating the employment of antileprotic drugs as a sort of "prophylactic" treatment to prevent the development of the disease in persons who have been exposed to the disease. Naturally, it would be very advantageous to know if such treatment is really effective.

Unfortunately, it was impossible to have well-controlled experimental groups under observation to settle this point definitely. However, certain pertinent data are available.

During the early part of September, 1924, Drs. Catalino Nicolas and Elisa Roxas-Pineda placed under treatment all children at Culion having suspicious lesions. Previous to this time, both of them had already been treating about fifteen of these cases. The nonleper children were also encouraged to receive injections.

According to their special reports dated October 15 and September, 1925, respectively, Nicolas and Roxas-Pineda treated, in all, eighty-three suspicious children for periods of time ranging from three months to four years; the majority received treatment for thirteen to fourteen months (from September, 1924). In seventy cases the children remained suspicious at the end of the treatment, although some degree of improvement in the lesion or lesions was noted in forty-eight of them; ten (12 per cent) had become either clinical or positive lepers; and in only three had the suspicious lesions disappeared. Recapitulating, it is demonstrated that of eighty-three suspicious cases placed under treatment for an average period of fourteen months, seventy, or 84 per cent, remained suspicious, while ten

(12 per cent) became clinical or bacteriologically positive lepers. Furthermore, of ten children presenting suspicious lesions treated by Nicolas and Roxas-Pineda for as long as from two to three years, eight had persisted as suspicious cases. However, it must be emphasized that all these children were living with their leper parents and, therefore, were continuously exposed to probable reinfection.

When it is recalled that many of the suspicious cases clear up and become nonleprous after some time, even without drug treatment, it becomes evident that the injections do not seem to be very effective in clearing up the suspicious lesions. On the contrary, of eighteen nonleper children who were injected more or less regularly by these same workers for about a year, sixteen had become suspicious, and only two remained symptom free. It must be repeated, however, that these workers had noted some degree of improvement in the extent and distinctness of the lesions, but apparently, the improvement was not marked enough to necessitate a change in classification of the cases. Furthermore, the dosage used for the suspicious cases as a rule was considerably less than that used for clinical and positive lepers. The injection of larger doses is attended with much pain and the drug is not uninjurious to certain vital organs, especially the kidneys, so that the physicians perforce had to be cautious in administering the treatment to children without definite lesions of leprosy.

When the drug treatment is given to the suspicious cases after they have been segregated, the results are somewhat more encouraging. It must be stated at the outset, however, that the records of the treatment of the segregated children were not as complete as could be desired.

In June, 1924, eighteen children having suspicious lesions and at that time segregated at the former Negative Children's Home at Balala, Culion, were given treatment with the iodized esters of *H. wightiana* oil. The injections were continued until they were transferred to Welfareville. Here, it is said that the injections were also given to all the children for a time, although no records are available. During the dysentery epidemic of 1926, the antileprotic injections were discontinued and were not resumed for some months.

It was not until September, 1927, when Dr. Elisa Roxas-Pineda took charge of the treatment of the Welfareville children, that records of the injections were kept. Only the suspicious cases were treated.

Only twelve of the eighteen children with suspicious lesions whose treatment was started in 1924 were at Welfareville at the time of the present survey. Two of these still had suspicious patches, two were clinical lepers, and eight, or about 66 per cent, were considered nonlepers.

Of the sixty-three Culion children who were considered "suspicious" at the time of transfer to Welfareville either in December, 1925, or in January of the following year, twenty-six, or almost 41 per cent, were found to be already clean and considered nonlepers at the end of 1929, while thirty-seven (59 per cent) were still suspicious. Five children transferred to Welfareville as "clinical lepers" had become nonlepers also, giving a total of forty-two children in a total of sixty-eight whose lesions had cleared up.

At the same time, five suspicious and clinically positive cases have become bacteriologically positive among the Welfareville children, in spite of the drug treatment.

From the foregoing observations, it would seem that the antileprotic drug treatment in suspicious children, even among segregated cases is of doubtful value, and that the so-called "prophylactic treatment" is not only unscientific but quite useless as well. Therefore, such treatment cannot be employed to shorten the necessary period of segregation for children who have been allowed to remain with their leper parents beyond the age of 6 months. This period of segregation should not be less than five years, whether the child is treated or not.

COMMENT

In following the development of leprosy among the Culion children through a period of several years, it is observed that in a typical case, there is a very gradual progress of the infection through the so-called "suspicious" (lasting from a few months to four years) and the "clinical leper" stages (lasting from a few weeks to four years) to a peak which begins to be reached when the organisms become demonstrable in the skin and mucous membranes. The bacilli usually appear in enormous numbers at these sites but eventually in the favorable cases, through the development perhaps of some degree of immunity and aided possibly by the drug treatment and especially by proper food and hygienic habits, the downward trend begins and the disease goes through a period of decreasing activity, until the skin and mucous membranes again become clear of organisms. Presumably, the trend continues downward through the subsequent stage of inactivity, arbitrarily

divided into "quiescent" and "arrested" periods, during which time the remaining organisms are gradually disposed of.

In some cases the suspicious or the clinical leper stage, or both, are skipped and the child becomes a "positive leper" directly from an apparently "nonleper" state.

The work in the Cebu Skin Dispensary indicates that the course of the disease in adults is essentially the same as in the leper children. However, the suspicious stage is practically nonexistent among adults and in its place there is a corresponding period characterized by the appearance of paræsthetic symptoms and signs of vasomotor instability, and less characteristically, by urticarialike rashes and epistaxis. The duration of this prodormal period is about the same as the suspicious stage in children.

I have yet to see a "tuberculoid" (zone) type of lesion in young children.

The drug treatment as a rule is not effective in the "suspicious" or "prodromal" and the early "clinical leper" stages, but due perhaps to the gradual development of some degree of immunity and partly to greater accessibility or vulnerability of the bacilli to the drug, its effects become more manifest after the organisms have appeared in their typical form in the dermis.

SUMMARY AND CONCLUSION

1. Three hundred ninety-eight children born in the Culion Leper Colony were traced and as many as possible were reexamined five years after they were first surveyed in 1924.

As of December 31, 1929, sixty-two could no longer be traced and identified due to destruction of part of my records. A total of fifty-six of the whole group had died, ninety were at Welfareville, and one hundred six had been discharged and placed under the care of nonleper guardians.

Eighty-five had become at one time or other "positive" or confirmed lepers and of these, fifty had become "negative" and paroled; thirty-one were still segregated at Culion or at San Lazaro Hospital in Manila as lepers, and four had died.

Only those who were living at Welfareville together with those still remaining at Culion and San Lazaro Hospital, and three of the discharged cases, could be reëxamined. Of the Welfareville children, five were "arrested" cases, thirteen had suspicious lesions of leprosy, and sixty-eight were considered nonlepers. Four of the thirty-one lepers still remaining in the leprosaria at the end of 1929 were already candidates for the "quiescent" period.

2. Since 1926, children born at Culion are transferred at birth, or as soon thereafter as possible, to a nursery in the nonleper settlement. Upon reaching the age of 2 years, they are taken to Welfareville, at Manila. From Welfareville a child may be given to a guardian, provided that after due investigation, the qualifications of the guardian are acceptable to the Public Welfare Commissioner or his authorized representatives.

3. There has been a very distinct diminution in the number found becoming bacteriologically positive since 1926. This drop is partly due to the favorable effect of the treatment among the clinical lepers, partly to the diminishing number under observation, also to the excellent care and good food given to the infants at the nursery at Culion and to the older children at Welfareville, but especially to the fact that since 1925, the children born at Culion have been separated from their parents very soon after birth. Adequate care and proper food are more effective in preventing the development of the disease among these children, than any medication.

4. The drug treatment as a rule is not effective in the "suspicious" or "prodromal" and the early "clinical leper" stages, but due perhaps to the gradual development of some degree of immunity and partly to greater accessibility or vulnerability of the bacilli to the drug, its effects become more manifest after the organisms have appeared in their typical form in the dermis.

5. Children removed from leper surroundings after the first six months of life should be segregated for at least five years. "Preventive" treatment with antileprotic drugs cannot take the place, nor shorten the duration, of this observation period.

6. It is possible to make a clinical diagnosis of leprosy months or years before the presence of *M. lepræ* can be demonstrated in the skin and mucous membranes by the ordinary methods of bacteriological examination.

7. A suspicious lesion that appears in infants less than 2 years of age, consisting of a flushed, tense, and shiny condition of the front of the legs, is described. The designation "Nicolas sign" is proposed for this condition.

ACKNOWLEDGMENT

Acknowledgment is due to Dr. Elisa Roxas-Pineda for the use of her personal records and reports on the Culion children in the preparation of this article.

A NEW SPECIES OF HOOKWORM FROM A PHILIPPINE CIVET

By B. G. CHITWOOD

Of the Zoölogical Division, Bureau of Animal Industry
United States Department of Agriculture

ONE PLATE

January 30, 1930, Dr. E. W. Price, of the Bureau of Animal Industry, collected a number of hookworms from the small intestine of a Philippine civet (*Paradoxurus philippinensis*) which had died at the National Zoölogical Park, Washington, D. C. These worms belong to the genus *Uncinaria* and represent a new species for which the name *Uncinaria philippinensis* is proposed.

UNCINARIA PHILIPPINENSIS sp. nov.

Specific diagnosis. Uncinaria.—Anterior end bent dorsally. Buccal capsule 85 to 100 μ long by 75 to 90 μ wide in the female, and 80 to 95 μ long by 60 to 80 μ wide in the male, formed of heavily cuticularized plates; surface of buccal capsule does not present conspicuous sutures as found in *Uncinaria lotoris;* two large subventral cutting plates guard opening of mouth; ventral side of mouth opening laterally constricted. Four submedian papillæ and one pair of lateral organs or amphids are present. A pair of subventral teeth or lancets project from wall of buccal capsule near base of buccal cavity. Dorsal œsophageal gland opens at end of dorsal gutter. Musculature attached to dorsal side of buccal capsule is very conspicuous. Cuticle rather thick; striæ distinct.

Male 3.29 to 3.38 millimeters long by 180 to 200 μ wide. Œsophagus club-shaped, 420 to 440 μ long, with a minimum diameter of 40 μ in region of nerve ring and a maximum diameter of 60 to 65 μ near base of posterior enlargement of œsophagus. Nerve ring situated 200 to 210 μ from anterior end of body. Excretory pore a short distance posterior to nerve ring, 300 to 310 μ from anterior end. Excretory duct bends posteriorly from excretory pore and bifurcates, each branch entering an enormous subventral excretory cell which varies in length but

is usually about twice the length of the œsophagus. Spicules slender and setalike, 1.2 to 1.25 millimeters long, maximum diameter 6 to 8 μ at proximal end; distinctly striated except near distal end. Gubernaculum slender, 70 to 90 μ long, with a slight bend near posterior fourth of its length. Prebursal papillæ 180 μ from posterior end of body. Lateral bursal lobes nearly semicircular in contour. Dorsal ray bifurcates about three-fourths of its length from the anterior end forming secondary branches, each of which bifurcates to form tertiary branches, the innermost branches being bidigitate and thicker than the outer branches; thus the distal portion of the dorsal ray consists of two tridigitate branches, the inner digit in each case being the longest and the outer digit the shortest. Externolateral ray shorter than mediolateral. Posterolateral ray attached near the base of common stalk of externolateral and mediolateral rays, and usually slightly thicker than the other rays. The other rays do not differ from those of other members of the genus.

Female 3.3 to 3.5 millimeters long by about 200 μ wide at base of œsophagus, and 250 to 300 μ wide in region of vulva. Œsophagus 460 to 500 μ long with a minimum diameter of 44 μ in region of nerve ring and a maximum diameter of 88 μ at the base. Nerve ring situated 260 μ, and excretory pore 340 to 360 μ, from anterior end of body. Tail bluntly conical, 100 to 180 μ long, and provided with a fine point at its tip. Vulva 2.4 to 2.5 millimeters from anterior end of body. Eggs 60 to 66 μ long by 34 to 38 μ wide.

Host.—*Paradoxurus philippinensis.*

Location.—Small intestine.

Distribution.—National Zoölogical Park, Washington, D. C.

Type specimens.—United States National Museum helminthological collection, No. 29723; paratypes, No. 31272.

Uncinaria philippinensis is distinctly smaller than the three other species of the genus. The size varies little in a collection of thirty-five individuals. *Uncinaria lotoris* is characterized by the presence of distinct sutures in the buccal capsule, which sutures were not seen in *U. philippinensis.* The latter differs from *U. criniformis* in that the posterolateral bursal ray is thicker than the mediolateral. It differs from *U. stenocephala,* as also from the other species, in the proportionate, as well as the absolute, size of the spicules. These differences are brought out in the following key.

Key to the species of the genus Uncinaria.

1. Buccal capsule showing distinct sutures .... *U. lotoris.*
   Buccal capsule not showing distinct sutures .... 2.
2. Dorsal ray bifurcate, each branch bidigitate.......... *U. criniformis.*
   Dorsal ray bifurcate, each branch tridigitate .... 3.
3. Male 5.6 to 8 millimeters long, female 7.7 to 12 millimeters long; spicules 140 to 760 μ long.......... *U. stenocephala.*
   Male 3.29 to 3.38 millimeters long, female 3.3 to 3.5 millimeters long; spicules 1.2 to 1.5 millimeters long.......... *U. philippinensis.*

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ILLUSTRATION

PLATE 1. UNCINARIA PHILIPPINENSIS SP. NOV.

FIG. 1. Lateral view of head.
2. Dorsal view of head.
3. Lateral view of anterior end.
4. Lateral view of male tail.
5. Dorsal view of male tail.

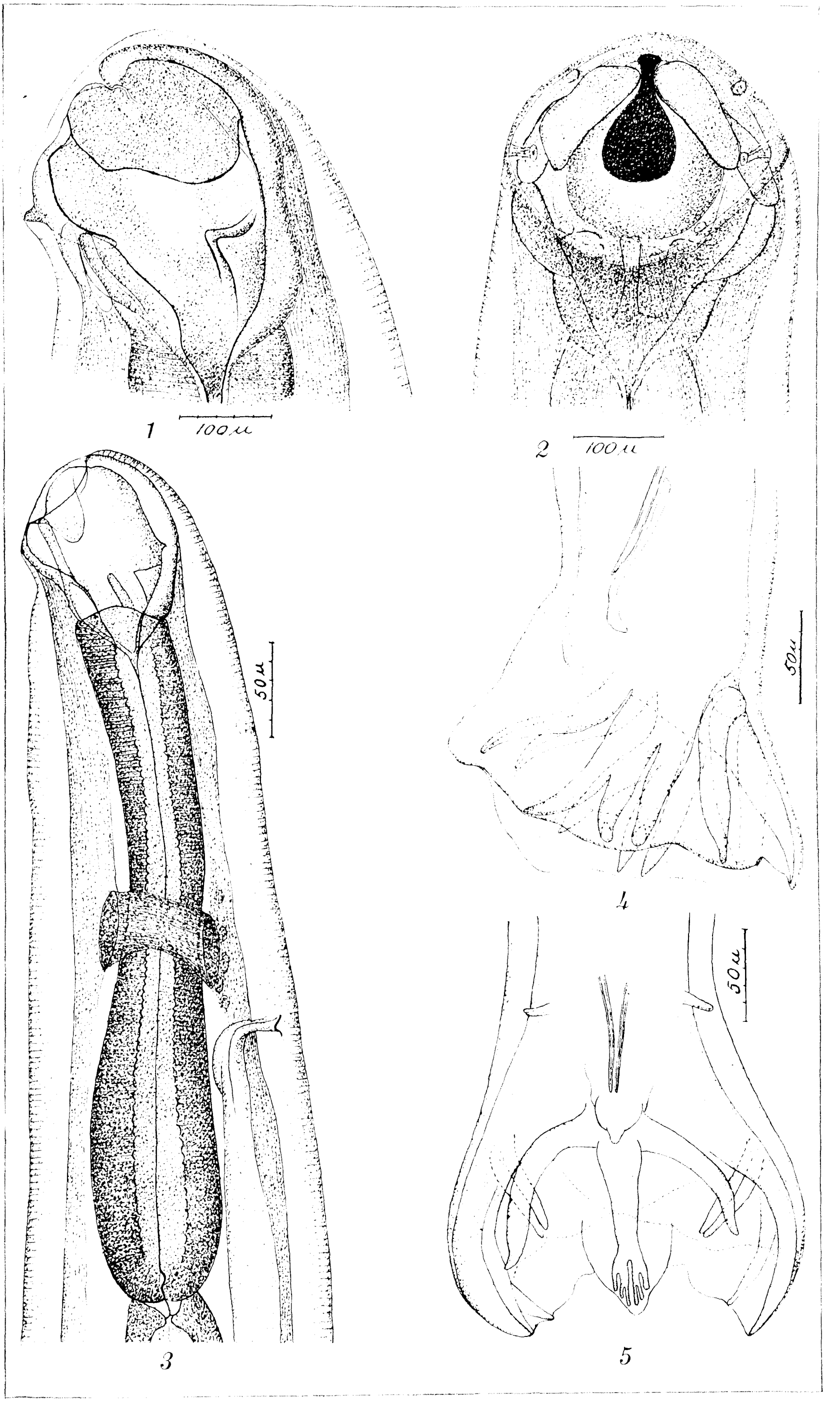

PLATE 1.

DIATOMS FROM THE BOTTOM OF THE SEA OF JAPAN

By B. W. Skvortzow

Of Harbin, China

FOUR PLATES

The diatoms described in the following paper were collected in 1921–1925 by the Imperial Fisheries Institute of Tokyo, Japan, and sent to me by the kindness of Dr. K. Okamura, director of that institute.

Five samples of sea mud were included in the shipment, as follows:

1. A sandy sea mud with small *Coscinodiscus* and various Naviculaceæ. Collected at 124° 52′ 10″ east, 35° 55′ 30″ north. November 14, 1923.
2. A sea mud with a large number of *Coscinodiscus* valves. Collected at 138° 13′ 00″ east, 38° 38′ 50″ north. July 10, 1921.
3. Also a *Coscinodiscus* mud. Collected at 142° east, 38° 17′ north. November 24, 1925.
4. A sea mud with radiolarians and large *Coscinodiscus* valves. Collected at 141° 42′ east, 38° 17′ north. December 21, 1925.
5. A calcareous mud with very few diatoms. Collected at 134° 56′ 30″ east, 39° 11′ 20″ north. July 10, 1921.

The material contained eighty-three species and varieties of diatoms, among which were found several new forms. The diatoms of the Sea of Japan are still relatively little known and our list can be of interest. The diatoms found in these collections are here enumerated. The number after each species corresponds to the particular locality from which it was obtained.

MELOSIRA SULCATA (Ehrenberg) Kützing forma **CORONATA** Grunow.

Length, 0.01 to 0.012 millimeter; breadth, 0.05. Geographic distribution: North and Mediterranean Seas. Samples 1 and 3.

PODOSIRA STELLIGER (Bailey) Mann.

V. Heurck, Synopsis. pl. 84, figs. 1, 2.

Diameter of the valve 0.059 to 0.062 millimeter. Geographic distribution: Pacific and Atlantic Oceans. Samples 2 and 4.

HYALODISCUS SUBTILIS Bailey.

PERAGALLO, Diatom. Mar. France. pl. 119, fig. 7.

Diameter of the valves 0.047 to 0.051 millimeter. Geographic distribution: Atlantic and Pacific Oceans. Samples 1, 2, and 3.

AULISCUS COELATUS Bailey. Plate 2, figs. 1 to 3.

A. SCHMIDT, Atlas Diatom. pl. 32, figs. 14 to 20.

Diameter of the valves 0.042 to 0.062 millimeter. Geographic distribution: Atlantic and Pacific Oceans. Sample 1.

CERATAULUS TURGIDUS Ehrenberg.

V. HEURCK, Synopsis. pl. 104, figs. 1, 2.

Diameter of the valves 0.068 to 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans. Sample 1.

CYCLOTELLA STRIATA (Kützing) Grunow.

V. HEURCK, Synopsis. pl. 92, figs. 6 to 8.

Diameter of the valve 0.032 millimeter. Striæ 12 in 0.01 millimeter. Geographic distribution: Brackish and marine waters. Sea of Japan, Yellow Sea, Atlantic and Pacific Oceans. Samples 1, 2, 3, and 4.

BIDDULPHIA GRUNDLERI A. Schmidt. Plate 2, fig. 4.

A. SCHMIDT, Atlas Diatom. pl. 118, figs. 22 to 24.

Geographic distribution: Pacific Ocean and Sea of Japan. Samples 2 and 4.

BIDDULPHIA RETICULATA Roper.

A. SCHMIDT, Atlas Diatom. pl. 121, figs. 11 to 15.

Length, 0.051 millimeter; breadth, 0.034. Geographic distribution: Celebes, Sandwich Islands, Java, Sea of Japan, Ceylon. Samples 1, 2, and 3.

BIDDULPHIA AURITA (Lyngb.) Brébisson.

V. HEURCK, Synopsis pl. 98, figs. 4 to 9.

Length, 0.6 to 0.07 millimeter; breadth, 0.035. Geographic distribution: Adriatic Sea and Pacific Ocean. Samples 1, 2, and 3.

BIDDULPHIA LONGICRURIS Greville. Plate 4, figs. 8, 10.

A. SCHMIDT, Atlas Diatom. pl. 118, fig. 10.

Length, 0.054 millimeter; breadth, 0.017 to 0.034. Our valves were without horns. Geographic distribution: Honkong, Japan. Sample 5.

ARACHNOIDISCUS EHRENBERGII Bailey var. CALIFORNICA Grunow. Plate 1, fig. 9.

A. SCHMIDT, Atlas Diatom. pl. 68, figs. 3 to 4.

Diameter of the valves 0.165 to 0.195 millimeter. Geographic distribution: Sea of Okhotsk, Bering Sea, Aleutian and Honshu Islands, Japan, Yokohama. Sample 1.

ACTINOPTYCHUS PARVUS Mann. Plate 1, fig. 10.

Marin. Diatom. Philippine Islands. (1925) 15, pl. 1, fig. 8.

Diameter of the valves 0.055 to 0.062 millimeter. Geographic distribution: Atlantic and Pacific Oceans, Philippines, Sea of Japan. Samples 1 and 3.

ACTINOPTYCHUS UNDULATUS (Bailey) Ralfs.

V. HEURCK, Synopsis. pl. 122, figs. 1, 3.

Diameter of the valves 0.051 millimeter. Geographic distribution: Atlantic and Pacific Oceans. Samples 1, 3, 5, and 6.

ASTEROMPHALUS CLEVEANUS Grunow. Plate 4, fig. 1.

A. SCHMIDT, Atlas Diatom. pl. 38, figs. 13 to 14.

Diameter of the valves 0.068 to 0.096 millimeter. Geographic distribution: Java, Manila, Indian Archipelago, Japan Sea. Samples 4 and 5.

ASTEROMPHALUS HUMBOLDTII Ehrenberg. Plate 4, fig. 2.

A. SCHMIDT, Atlas Diatom. pl. 38, figs. 18 to 20.

Diameter of the valves 0.068 to 0.072 millimeter. Geographic distribution: Indian Archipelago. Samples 4 and 5.

ACTINOCYCLUS EHRENBERGI Ralfs.

V. HEURCK, Synopsis. pl. 123, fig. 7.

Diameter of the valves 0.093 millimeter. Geographic distribution: A cosmopolitan diatom. Samples, 2, 3, and 4.

ACTINOCYCLUS EHRENBERGI Ralfs var. CRASSA (W. Smith) Hustedt.

V. HEURCK, Synopsis. pl. 124, figs. 6, 8.

Diameter of the valves 0.083 millimeter. Geographic distribution: North sea. Sample 2.

COSCINODISCUS LINEATUS Ehrenberg.

A. SCHMIDT, Atlas Diatom. pl. 59, figs. 31, 32.

Geographic distribution: A cosmopolitan diatom. Samples 3, 4, and 5.

COSCINODISCUS CONCINNUUS W. Smith.

A. SCHMIDT, Atlas Diatom. pl. 144, figs. 8, 9.

Geographic distribution: Atlantic and Pacific Oceans. Samples 4 and 5.

COSCINODISCUS EXTRAVAGANS A. Schmidt. Plate 1, fig. 1.

A. SCHMIDT, Atlas Diatom. pl. 58, fig. 33.

Diameter of the valve 0.072 millimeter. Central space circular. Markings small, granular, about 9 to 10 in 0.01 millimeter, in radial rows, fasciculate. Border distinct, striated. Geographic distribution: Sea of Japan. Samples 3 and 4.

COSCINODISCUS OKAMURÆ sp. nov. Plate 1, fig. 6.

Diameter of the valves 0.037 to 0.04 millimeter. Central space large, about one-third of the diameter broad, irregular. Markings round, granula 5 to 6 in 0.01 millimeter, with central distinct papillæ, all of the same size. Border distinct, toward the border passing in spiral lines. Border 0.0017 to 0.002 millimeter broad, with coarse striæ, 12 in 0.01 millimeter. Sample 1. Named in honor of Dr. K. Okamura.

COSCINODISCUS JANISCHII A. Schmidt.

A. SCHMIDT, Atlas Diatom. pl. 64, figs. 3, 4.

Diameter of the valves 0.165 to 0.196 millimeter. Markings 3 to 4 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans. Samples 4 and 5.

COSCINODISCUS OCULUS IRIDIS Ehrenberg.

A. SCHMIDT, Atlas Diatom. pl. 63, figs. 6, 7, 9.

Diameter of the valves 0.125 to 0.165 millimeter. Geographic distribution: A cosmopolitan diatom. Samples 3, 4, and 5.

COSCINODISCUS RADIATUS Ehrenberg. Plate 1, fig. 2.

A. SCHMIDT, Atlas Diatom. pl. 60, figs. 1 to 6, 9, 10; pl. 61, fig. 18; pl. 65, fig. 8.

Diameter of the valve 0.098 millimeter. Markings 2 to 3 in 0.01 millimeter. Geographic distribution: A cosmopolitan diatom. Samples 3, 5, and 6.

COSCINODISCUS RADIATUS Ehrenberg var. MINOR A. Schmidt.

A. SCHMIDT, Atlas Diatom. pl. 60, figs. 1 to 4.

Diameter of the valves 0.025 to 0.044 millimeter. Markings 4 to 6 in 0.01 millimeter. Geographic distribution: Common with the typical form. Samples 3, 5, and 6.

COSCINODISCUS MARGINATUS Ehrenberg. Plate 1, fig. 7.

A. SCHMIDT, Atlas Diatom. pl. 62, figs. 1 to 5, 7, 9, 11, 12.

Diameter of the valves 0.085 to 0.12 millimeter. Geographic distribution: Pacific and Atlantic Oceans. Sea of Japan. Samples 3, 4, and 5.

COSCINODISCUS CURVATULUS Grunow. Plate 2, fig. 5.

GRUNOW, Diatom. Franz Josef Land. p. 83, pl. D. figs. 9, 11, 12.

Diameter of the valves 0.093 to 0.1 millimeter. Markings 5 to 7 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans. Samples 4 and 5.

COSCINODISCUS OBSCURUS A. Schmidt. Plate 1, fig. 5.

A. SCHMIDT, Atlas Diatom. pl. 61, fig. 16.

Diameter of the valve 0.056 millimeter. Markings 3 to 3.5 in 0.01 millimeter. Geographic distribution: Pacific Ocean and fossil.

COSCINODISCUS EXCENTRICUS Ehrenberg. Plate 1, fig. 4.

A. SCHMIDT, Atlas Diatom. pl. 58, figs. 46 to 49.

Diameter of the valve 0.075 to 0.086 millimeter. Markings 3 to 4 in 0.01 millimeter. Geographic distribution: A cosmopolitan diatom. Samples 1, 2, 3, 4, and 5.

COSCINODISCUS SUBCONCAVUS Grunow var. **JAPONICA** var. nov. Plate 1, fig. 8.

Central space absent. Markings hexagonal, angular in contact. Apiculi distinct, large. Diameter of the valves 0.027 to 0.033 millimeter. Markings at the center 2.5 to 3 in 0.01 millimeter. Geographic distribution: *Coscinodiscus subconcavus* is known as a fossil from Simbirsk, A. Schmidt, Atlas Diatom. pl. 58, figs. 12, 13. Samples 5 and 6.

COSCINODISCUS PERFORATUS Ehrenberg. Plate 1, fig. 3.

A. SCHMIDT, Atlas Diatom. pl. 64, figs. 12 to 14.

Diameter of the valves 0.08 to 0.105 millimeter. Geographic distribution: Pacific Ocean, Mediterranean and North Seas. Samples 4 and 5.

DICHAMERIS VENTRICOSA Castracane. Plate 2, fig. 6.

Challenger Exped. Diatom. p. 150, pl. 12, figs. 5 to 6.

Valves lunate with broad, rounded dorsal and flat ventral margin. Markings distinct, radiate. Length, 0.085 millimeter; breadth, 0.057. Geographic distribution: Sea of Japan. Sample 3.

DITYLIUM BRIGHTWELLII (West) Grunow.

PERAGALLO, Diatom. Mar. France. pl. 46, figs. 6, 11.

Diameter of the valves 0.076 to 0.08 millimeter. Striæ 15 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans. Sample 1.

BACTERIASTRUM VARIANS Lauder.

LAUDER, Hongkong Diatom. (1864) figs. 1 to 5.

Geographic distribution: Atlantic and Pacific Oceans. Samples 1, 3, and 4.

GRAMMATOPHORA ANGULOSA Ehrenberg var. **HAMULIFERA** Kützing.

PERAGALLO, Diatom. Mar. France. pl. 88, figs. 16, 17.

Length, 0.034 millimeter; breadth, 0.017. Striæ 18 to 20 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans. Samples 1, 2, and 3.

GRAMMATOPHORA OCEANICA Ehrenberg var. **MACILENTA** Smith.

V. HEURCK, Synopsis. pl. 53, fig. 14.

Length, 0.132 millimeter; width, 0.01. Geographic distribution: Atlantic, North Sea. Samples 1 and 3.

GRAMMATOPHORA OCEANICA Ehrenberg var. **ADRIATICA** Grunow.

PERAGALLO, Diatom. Mar. France. pl. 87, fig. 19.

Length, 0.052 millimeter; width, 0.01. Geographic distribution: Atlantic and Pacific Oceans. Samples 1, 3, and 4.

GRAMMATOPHORA JAPONICA Grunow.

PERAGALLO, Diatom. Mar. France. pl. 87, fig. 26.

Length, 0.042 millimeter; breadth, 0.02. Geographic distribution: Sea of Japan. Samples 1, 3, and 4.

DIMEROGRAMMA MINOR Gregory.

V. HEURCK, Synopsis. pl. 36, figs. 10, 11a.

Length, 0.037 millimeter; breadth, 0.0085. Striæ 9 in 0.01 millimeter. Geographic distribution: Atlantic Ocean. Sample 5.

RHAPHONEIS SURIRELLA (Ehrenberg) Grunow var. **AUSTRALIS** (Petit) Grunow. Plate 3, figs. 1, 2.

V. HEURCK, Synopsis. pl. 36, fig. 27b.

Length, 0.042 millimeter; breadth, 0.02. Puncta 7 in 0.01 millimeter. Geographic distribution: Pacific Ocean. Sample 1.

RHAPHONEIS ELLIPTICA Castracane.

CASTRACANE, Diatom. Challenger. p. 49, pl. 26, fig. 13.

Length, 0.074 to 0.081 millimeter; breadth, 0.025 to 0.04. Striæ 4 to 6 in 0.01 millimeter. Geographic distribution: Sea of Japan. Sample 1.

SYNEDRA CRYSTALLINA Lyngbye var. **CONSPICUA** Grunow.

PERAGALLO, Diatom. Mar. France. pl. 79, fig. 4.

Length, 0.51 millimeter; breadth, 0.015. Geographic distribution: North and Mediterranean Seas. Sample 1.

THALASSIONEMA NITZSCHIOIDES Grunow.

PERAGALLO, Diatom. Mar. France. pl. 81, fig. 17.

Length, 0.027 to 0.029 millimeter; breadth, 0.002 to 0.0025. Striæ 9 to 10 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans. Sea of Japan, China Sea. Samples 1 and 5.

COCCONEIS HETEROIDEA Hantzsch var. **CURVIROTUNDA** Tempere and Brun.

A. SCHMIDT, Atlas Diatom. pl. 195, figs. 10 to 17.

Valve elliptic. Length, 0.056 millimeter; breadth, 0.037. Geographic distribution: Japan fossil. Samples 1, 3, and 4.

COCCONEIS PELLUCIDA Hantzsch.

A. SCHMIDT, Atlas Diatom. pl. 195, figs. 7 to 9.

Valve robust, elliptic. Length, 0.081 millimeter; breadth, 0.059. Geographic distribution: Nicobar and Sandwich Islands, Java, Sumatra, Singapore, Bering Island, Madagascar, New Zealand, Hungary and Haiti fossil. Sample 1.

COCCONEIS PELLUCIDA Hantzsch var. **MINOR** Grunow.

Reise Novara, Algen. (1867) 13, pl. 1, fig. 7.

Valve broadly elliptical. Length, 0.032 millimeter; breadth, 0.022. Geographic distribution: Red Sea, St. Paul Island, Cape of Good Hope, Nicobar Islands, New Zealand, Trinidad. Sample 1.

COCCONEIS SCUTELLUM Ehrenberg var. **GENUINA** Cleve.

V. HEURCK, Synopsis. pl. 29, figs. 1, 2.

Valve elliptical. Length, 0.034 millimeter; breadth, 0.022. Geographic distribution: A cosmopolitan diatom. Sample 1.

NAVICULA JEJUNA A. Schmidt. **Plate 4, fig. 7.**

A. SCHMIDT, Atlas Diatom. pl. 46, fig. 76; CASTRACANE, Challenger, Voy. p. 33, pl. 20, fig. 12, pl. 28, fig. 11.

Length, 0.12 millimeter; breadth, 0.012. Striæ 4 in 0.01 millimeter. Geographic distribution: Java, Sumatra, Singapore, Makassar Strait, Japan. Sample 1.

NAVICULA YARRENSIS Grunow.

A. SCHMIDT, Atlas Diatom. pl. 46, figs. 1 to 6.

Valve lanceolate with obtuse ends. Length, 0.091 millimeter; breadth, 0.017. Striæ 4 in 0.01 millimeter. Geographic distribution: Brackish water. Kiel, Hungary fossil, Africa, Madagascar, Singapore, Ceylon, Java, Japan, Australia, Florida, Atlantic City, New Jersey, United States, Kamerun. Sample 1.

NAVICULA LYRA Ehrenberg var. INTERMEDIA Peragallo. Plate 3, fig. 7.

PERAGALLO, Diatom. Mar. France. pl. 27, fig. 6.

Length, 0.085 to 0.095 millimeter. Striæ 6 in 0.01 millimeter. Geographic distribution: North and Mediterranean Seas, Atlantic and Pacific Oceans. Sample 1.

NAVICULA LYRA Ehrenberg var. INTERMEDIA Peragallo forma ELLIPTICA Peragallo.

PERAGALLO, Diatom. Mar. France. p. 136, pl. 23, figs. 8 to 10.

Valve elliptical. Length, 0.119 millimeter; breadth, 0.039. Striæ 12 in 0.01 millimeter. Geographic distribution: Mediterranean Sea, Atlantic Ocean. Sample 1.

NAVICULA LYRA Ehrenberg var. ELLIPTICA A. Schmidt. Plate 3, fig. 9.

A. SCHMIDT, Atlas Diatom. pl. 1, fig. 29.

Valve elliptical. Length, 0.054 to 0.08 millimeter; breadth, 0.028 to 0.034. Striæ 8 to 9 in 0.01 millimeter. Geographic distribution: North, Mediterranean, and Red Seas, Ceylon, Madagascar, Seychelles, Sumatra, Philippines, Singapore, Moravia fossil. Sample 1.

NAVICULA FORCIPATA Greville.

A. SCHMIDT, Atlas Diatom. pl. 70, fig. 17.

Valve elliptical, with rounder, slightly subrostrate ends. Length, 0.042 millimeter; breadth, 0.02. Striæ 14 to 15 in 0.01 millimeter. Geographic distribution: Greenland, North, Mediterranean, Black, and Red Seas, Cape of Good Hope, Nicobar, Galapagos, and Philippine Islands, California, Florida, Hungary fossil. Sample 1.

NAVICULA BRASILIENSIS Grunow. Plate 3, fig. 12.

A. SCHMIDT, Atlas Diatom. pl. 6, figs. 19 to 25, 31 to 33.

Length, 0.039 to 0.076 millimeter; breadth, 0.02 to 0.032. Striæ 9 to 10 in 0.01 millimeter. Geographic distribution: Atlantic coast of North America, West Indies, Campeche Bay, Bra-

zil, Bab el Mandeb, Zanzibar, Madagascar, Ceylon, Singapore, Labuan, China, Japan, New Caledonia, Samoa, Sandwich Islands. Samples 1, 2, and 3.

NAVICULA GRANULATA Bailey var. **JAPONICA** var. nov. Plate 3, fig. 11.

Valve long-elliptic, with rounded ends. Axial area linear, narrowed towards the central nodule and the ends. Striæ 10 in 0.01 millimeter, slightly radiate throughout. Length, 0.075 millimeter; breadth, 0.027. Geographic distribution: The typical form is known from North and Mediterranean Seas, Ceylon, Japan, Sydney, California. Samples 1 and 2.

DIPLONEIS COFFÆIFORMIS A. Schmidt. Plate 3, fig. 10.

PERAGALLO, Diatom. Mar. France. pl. 21, figs. 7 to 9.

Valve broadly elliptical. Length, 0.024 to 0.025 millimeter; breadth, 0.015 to 0.019. Striæ 9 to 10 in 0.01 millimeter. Geographic distribution: North Sea, Gulf of Naples, Makassar Strait, California fossil. Sample 1.

DIPLONEIS FUSCA Gregory. Plate 3, fig. 6.

A. SCHMIDT, Atlas Diatom. pl. 7, fig. 4.
PERAGALLO, Diatom. Mar. France. pl. 20, figs. 5, 6.

Valve elliptical robust. Length, 0.064 millimeter; breadth, 0.037. Striæ 7 in 0.01 millimeter. Geographic distribution: Adriatic and Pacific Oceans. Samples 1 and 2.

DIPLONEIS SMITHII Brébisson. Plate 2, fig. 8; Plate 3, fig. 8.

Valve elliptical. Length, 0.04 millimeter; breadth, 0.024. Striæ 7 in 0.01 millimeter. Geographic distribution: Franz Josef Land, Spitzbergen, Sea of Kara, Finmark, Gulf of Bothnia, Baltic, North, and Mediterranean Seas, Madagascar, Seychelles, Tasmania, Java, New Zealand, Colon, Campeche Bay. Samples 1 and 2.

DIPLONEIS CRABRO Ehrenberg var. **SUSPECTA** A. Schmidt. Plate 2, fig. 9; Plate 3, fig. 13.

A. SCHMIDT, Atlas Diatom. pl. 11, figs. 12, 13, 26, 27.

Length, 0.076 millimeter; breadth, 0.025. Costæ 4 to 5 in 0.01 millimeter. Geographic distribution: Manila, Singapore, Java, Japan, Galapagos Islands, Batavia, Campeche Bay. Samples 1 and 2.

DIPLONEIS COARCTATA A. Schmidt.

A. SCHMIDT, Atlas Diatom. pl. 11, figs. 30 to 32.

Valve panduriform. Length, 0.04 millimeter; breadth, 0.015. Striæ 8 in 0.01 millimeter. Geographic distribution: Campeche Bay, Cape Horn, Hungary fossil. Samples 1, 2, and 4.

DIPLONEIS BOMBUS Ehrenberg. Plate 2, figs. 7, 10.

A. SCHMIDT, Atlas Diatom. pl. 69, figs. 28, 29.

Length, 0.039 millimeter; breadth, 0.018. Striæ 6.5 in 0.01 millimeter. Geographic distribution: Finmark, North Sea, Morocco, Mediterranean, Adriatic, Black, and Caspian Seas, Madagascar, Japan, Java, Samoa, Galapagos Islands, Cape Horn, Brazil, Florida and Campeche Bay. Sample 1.

CALONEIS BREVIS Gregory. Plate 3, fig. 14.

V. HEURCK, Synopsis. p. 97, pl. 11, fig. 19.

Valve elliptic. Length, 0.057 to 0.075 millimeter; breadth, 0.023 to 0.03. Geographic distribution: Spitzbergen, Greenland, Finmark, North Sea, Cape Deschneff, Sweden, Sydney. Sample 1.

CALONEIS LIBER W. Smith var. **LINEARIS** Grunow.

A. SCHMIDT, Atlas Diatom. pl. 50, figs. 38, 40.

Valve linear. Length, 0.085 millimeter; breadth, 0.017. Striæ 18 in 0.01 millimeter. Geographic distribution: Atlantic coasts of Europe, Africa, and America, Ceylon, Singapore, Galapagos Islands, Peru, Honduras, Gulf of Mexico. Sample 1.

TRACHYNEIS VELATA A. Schmidt.

A. SCHMIDT, Atlas Diatom. pl. 48, figs. 33 to 34.

Valve lanceolate. With obtuse rounded ends. Length, 0.081 to 0.011 millimeter; breadth, 0.01 to 0.023. Striæ 10 to 17 in 0.01 millimeter. Geographic distribution: Cape of Good Hope, Madagascar, Mauritius, Ceylon, King George Sound, Sumatra, Java, China, Sandwich Islands, New Caledonia. Samples 3 and 5.

TRACHYNEIS ASPERA Ehrenberg var. **VULGARIS** Cleve. Plate 4, fig. 9.

A. SCHMIDT, Atlas Diatom. pl. 48, figs. 2 to 6.

Length, 0.081 millimeter; breadth, 0.015. Striæ 9 to 10 in 0.01 millimeter. Geographic distribution: Arctic America, North Sea, Cape of Good Hope, New Zealand, Samoa, New Caledonia, Java, Galapagos Islands. Samples 1 and 2.

PLEUROSIGMA ELONGATUM Smith.

PERAGALLO, Monogr. Pleurosigma p. 7, pl. 3, fig. 6.

Length 0.24 millimeter. Striæ 18 in 0.01 millimeter. Geographic distribution: Brackish water. Spitzbergen, Atlantic coast of North America, North, Mediterranean, Adriatic, Baltic, and Caspian Seas, Sumatra, China, Tahiti, Medoc. Samples 1 and 2.

GYROSIGMA DIAPHANUM Cleve.

Synopsis Navic. Diatom. part 2, p. 115, pl. 1, fig. 6.

Length, 0.093 millimeter; breadth, 0.017. Geographic distribution: Brehat Island, Sweden, France. Samples 1 and 5.

AMPHORA ANGUSTA (Gregory) Cleve var. **OKAMURÆ** var. nov. Plate 4, figs. 5 and 6.

Valve narrow, semilanceolate, subacute. Dorsal and ventral sides of the valve striated. Length, 0.051 to 0.061 millimeter; breadth, 0.012 to 0.015. Striæ 12 in 0.01 millimeter. Striæ on the dorsal side 6 to 7 in 0.01 millimeter. Named in honor of Dr. K. Okamura, Tokyo. Samples 1 and 2.

AMPHORA PROTEUS Gregory.

A. Schmidt, Atlas Diatom. pl. 27, fig. 3.

Length, 0.047 millimeter; breadth, 0.011. Striæ 12 in 0.01 millimeter. Geographic distribution: Greenland, Spitzbergen, Finmark, Sea of Kara, Cape Deschneff, St. Helena, Campeche Bay, Mediterranean and Black Seas, Seychelles, China, Galapagos Islands. Samples 1, 2, and 5.

AMPHORA RHOMBICA Kitton.

A. Schmidt, Atlas Diatom. pl. 40, fig. 39.

Length, 0.178 millimeter; breadth, 0.023. Striæ 11 in 0.01 millimeter. Geographic distribution: Mediterranean Sea, Island of Rhea, Sumbawa, Sumatra, Makassar Straits, China, Colon. Samples 1 and 2.

NITSCHIA OKAMURÆ sp. nov. Plate 4, fig. 4.

Valve narrow lanceolate elongate ends. Ends not capitate. Length, 0.06 to 0.065 millimeter; breadth, 0.004 to 0.005. Fine lines 20 in 0.01 millimeter. Coarse dorsal lines 7 to 8 in 0.01 millimeter. Samples 1 and 2.

NITSCHIA SIGMA Smith var. **INTERCEDANS** Grunow.

Peragallo, Diatom. Mar. France. pl. 74, fig. 7.

Length, 0.102 to 0.24 millimeter; breadth, 0.005 to 0.006. Coarse lines 9 in 0.01 millimeter. Geographic distribution: Atlantic and Pacific Oceans. Samples 1 and 2.

NITSCHIA PUNCTATA Smith var. **COARCTATA** Grunow.

Peragallo, Diatom. Mar. France. pl. 59, figs. 26 to 30.

Length, 0.034 millimeter; breadth, 0.015 millimeter. Geographic distribution: Atlantic and Pacific Oceans, Yellow Sea. Samples 1 and 2.

NITSCHIA JELINECKI Grunow. Plate 3, fig. 4.

A. SCHMIDT, Atlas Diatom. pl. 330, figs. 20, 21.

Length, 0.2 to 0.3 millimeter; breadth, 0.01. Geographic distribution: Brackish and marine waters, Kamerun, Borneo. Samples 1 and 2.

NITSCHIA (TRYBLIONELLA) CALIDA Grunow.

PERAGALLO, Diatom. Mar. France. pl. 59, fig. 10.

Length, 0.068 millimeter; breadth, 0.013. Fine lines 18 in 0.01 millimeter. Geographic distribution: Brackish and marine waters. Sample 1.

NITSCHIA TRYBLIONELLA Hantzsch var. **SUBSALINA** (O'Meara).

GRUNOW, forma subconstricta Hustedt. Plate 3, fig. 3.
A. SCHMIDT, Atlas Diatom. pl. 332, fig. 15.

Length, 0.073 millimeter; breadth, 0.018. Coarse lines 7.5 in 0.01 millimeter. Geographic distribution: Brackish and marine waters. Sample 1.

NITSCHIA TRYBLIONELLA Hantzsch var. **LEVIDENSIS** Smith.

PERAGALLO, Diatom. Mar. France. Pl. 69, fig. 5.

Length, 0.03 millimeter; breadth, 0.008. Striæ 12 in 0.01 millimeter. Geographic distribution: Fresh and brackish waters. Sample 1.

SYNEDRA FASTUOSA Ehrenberg var. **JAPONICA** var. nov. Plate 4, fig. 3.

Valve broad ovate with rounded end; rim heavy, strongly crossbarred; ribs or costæ beginning at the margin are thin, bearing two or three minute teeth on the broad outer ends; short and very thin costæ connect the small internal ends of the costæ with a narrow median area, which is bounded by a closely set row of transverse lines. Length, 0.109 to 0.12 millimeter; breadth, 0.073 to 0.08. Samples 1 and 3.

SURIRELLA FASTUOSA Ehrenberg. Plate 3, fig. 5.

PERAGALLO, Diatom. Mar. France. pl. 58, fig. 5.

Length, 0.063 millimeter; breadth, 0.04. Geographic distribution: A cosmopolitan diatom. Samples 3 and 4.

CAMPYLODISCUS LORENZIANUM Grunow.

A. SCHMIDT, Atlas Diatom. pl. 14, fig. 24.

Diameter of the valves 0.022 to 0.027 millimeter. Costæ 5.5 in 0.01 millimeter. Geographic distribution: Mediterranean Sea, Celebes. Sample 1.

CAMPYLODISCUS SAMOENSIS Grunow.

A. SCHMIDT, Atlas Diatom. pl. 15, fig. 13, 15, 18, 20.

Diameter of the valve 0.107 millimeter. Geographic distribution: Atlantic Ocean, Mediterranean and Yellow Seas. Sample 1.

CAMPYLODISCUS HOROLOGIUM Will. Plate 4, fig. 11.

A. SCHMIDT, Atlas Diatom. pl. 17, fig. 5.

Diameter of the valves 0.09 to 0.095 millimeter. Geographic distribution: North and Mediterranean Seas, Sea of Japan. Sample 1.

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ILLUSTRATIONS

Plate 1

FIG. 1. *Coscinodiscus extravagans* A. Schmidt forma.
2. *Coscinodiscus radiatus* Ehrenberg.
3. *Coscinodiscus perforatus* Ehrenberg.
4. *Coscinodiscus excentricus* Ehrenberg.
5. *Coscinodiscus obscurus* A. Schmidt.
6. *Coscinodiscus okamuræ* sp. nov.
7. *Coscinodiscus marginatus* Ehrenberg.
8. *Coscinodiscus subconcavus* Grunow var. *japonica* var. nov.
9. *Arachnoidiscus ehrenbergii* Bailey var. *californica* Grunow.
10. *Actinoptychus parvus* Mann.

Plate 2

FIGS. 1 to 3. *Auliscus coelatus* Bailey.
FIG. 4. *Biddulphia grundleri* A. Schmidt.
5. *Coscinodiscus curvatulus* Grunow.
6. *Dichameris ventricosa* Castracane.
7. *Diploneis bombus* Ehrenberg.
8. *Diploneis smithii* Brébisson.
9. *Diploneis crabro* Ehrenberg var. *suspecta* A. Schmidt.
10. *Diploneis bombus* Ehrenberg.

Plate 3

FIGS. 1 and 2. *Rhaphoneis surirella* (Ehrenberg) Grunow var. *australis* (Petit) Grunow.
FIG. 3. *Nitschia tryblionella* Hantzsch var. *subsalina* (O'Meara) Grunow forma *subconstricta* Hustedt.
4. *Nitschia jelinecki* Grunow.
5. *Surirella fastuosa* Ehrenberg.
6. *Diploneis fusca* Gregory.
7. *Navicula lyra* Ehrenberg var. *intermedia* Peragallo.
8. *Diploneis smithii* Brébisson.
9. *Navicula lyra* Ehrenberg var. *elliptica* A. Schmidt.
10. *Diploneis coffæiformis* A. Schmidt.
11. *Navicula granulata* Bailey var. *japonica* var. nov.
12. *Navicula brasiliensis* Grunow.
13. *Diploneis crabro* Ehrenberg var. *suspecta* A. Schmidt.
14. *Caloneis brevis* Gregory.

Plate 4

FIG. 1. *Asteromphalus cleveanus* Grunow.
2. *Asteromphalus humboldtii* Ehrenberg.

FIG. 3. *Synedra fastuosa* Ehrenberg var. *japonica* var. nov.
4. *Nitschia okamuræ* sp. nov.
FIGS. 5 and 6. *Amphora angusta* (Gregory) Cleve var. *okamuræ* var. nov.
FIG. 7. *Navicula jejuna* A. Schmidt.
8. *Biddulphia longicruris* Greville.
9. *Trachyneis aspera* Ehrenberg var. *vulgaris* Cleve.
10. *Biddulphia longicruris* Greville.
11. *Campylodiscus horologium* Will.

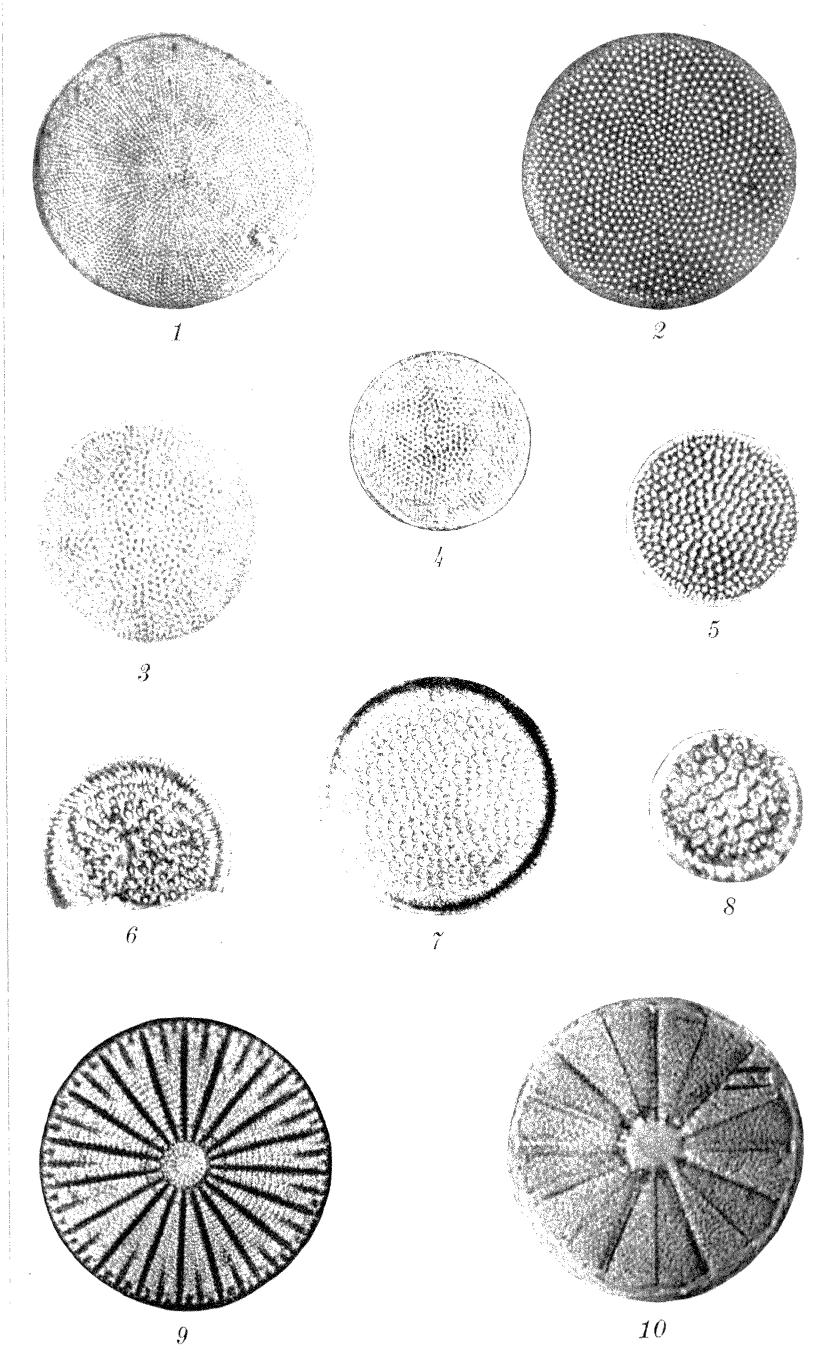

PLATE 1.

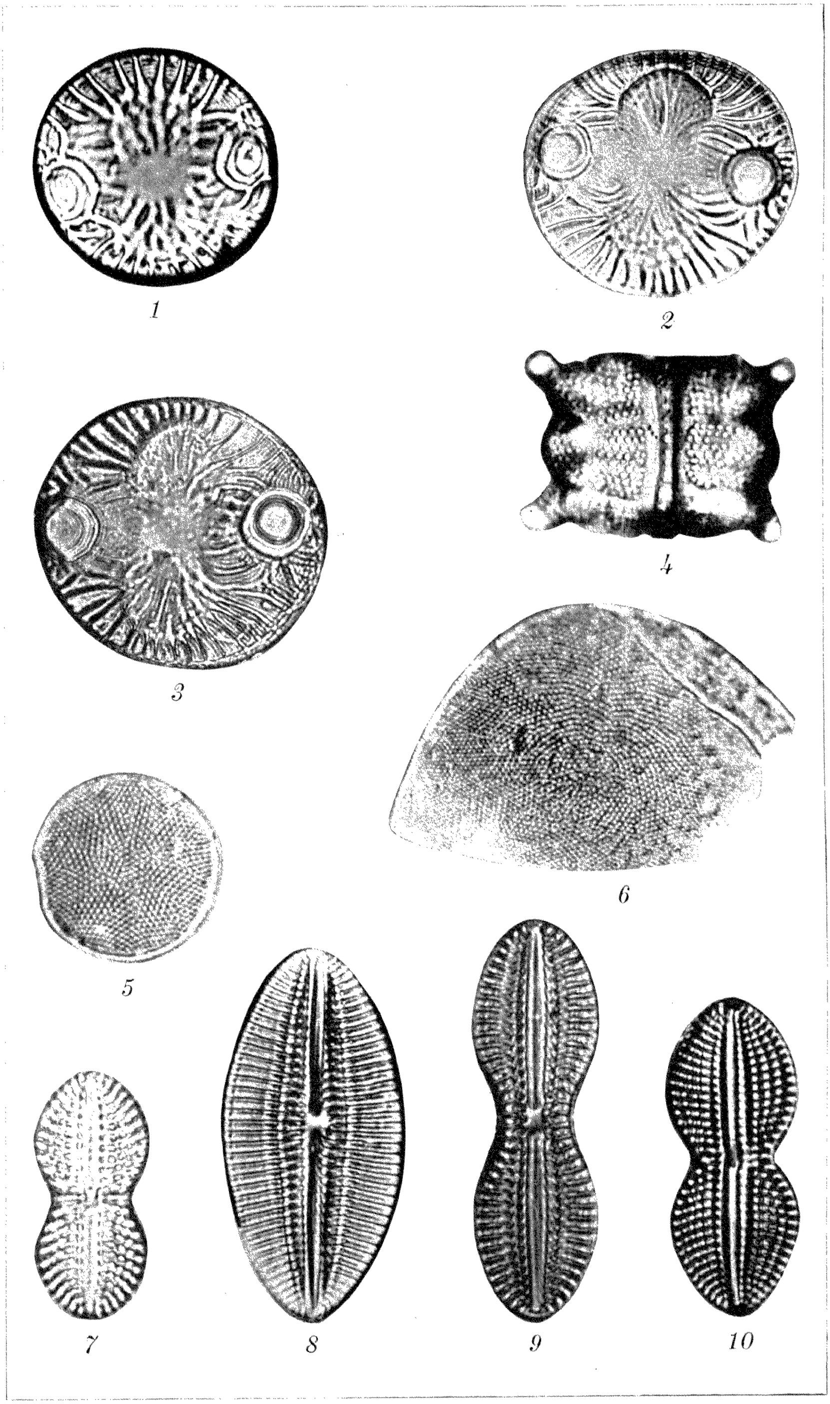

PLATE 2.

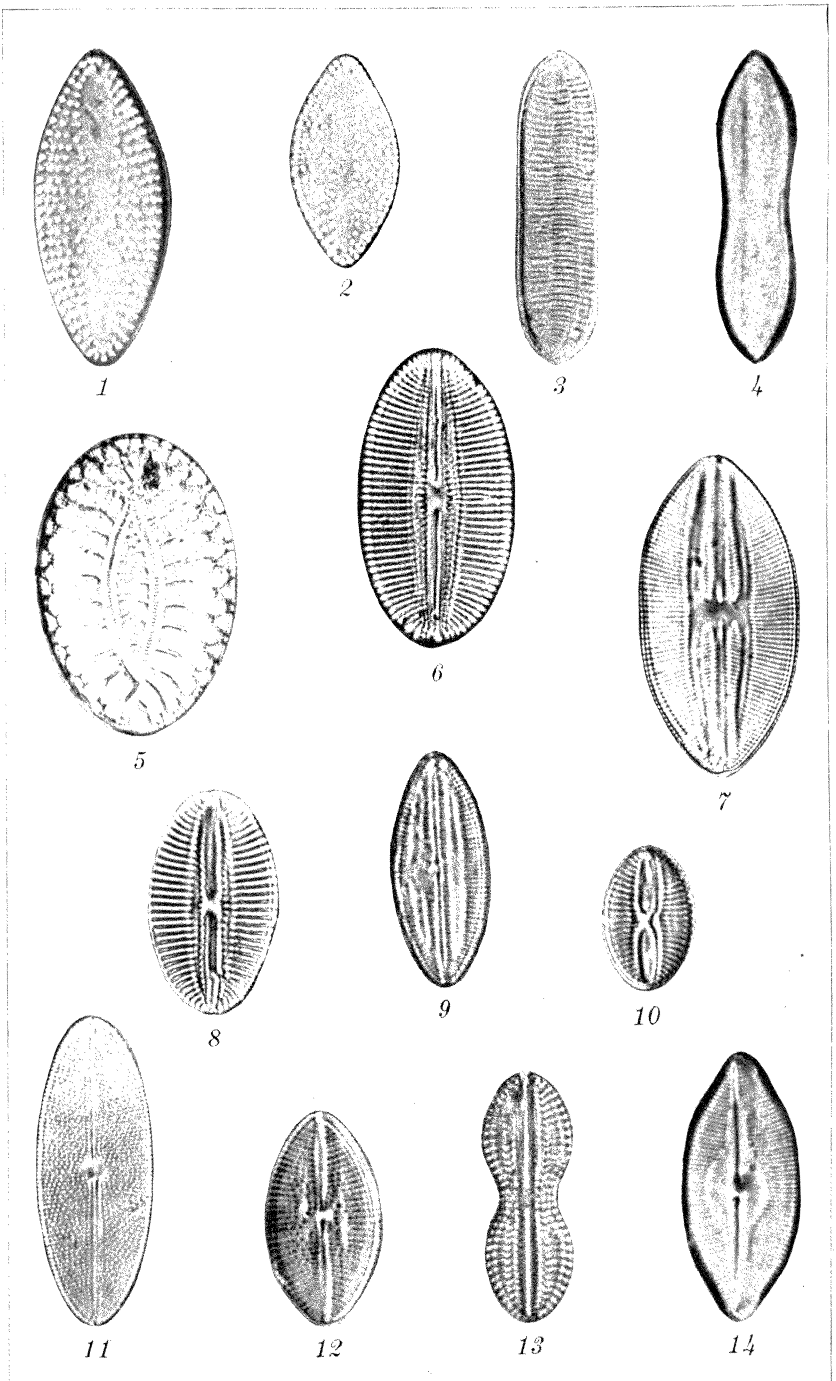

PLATE 3.

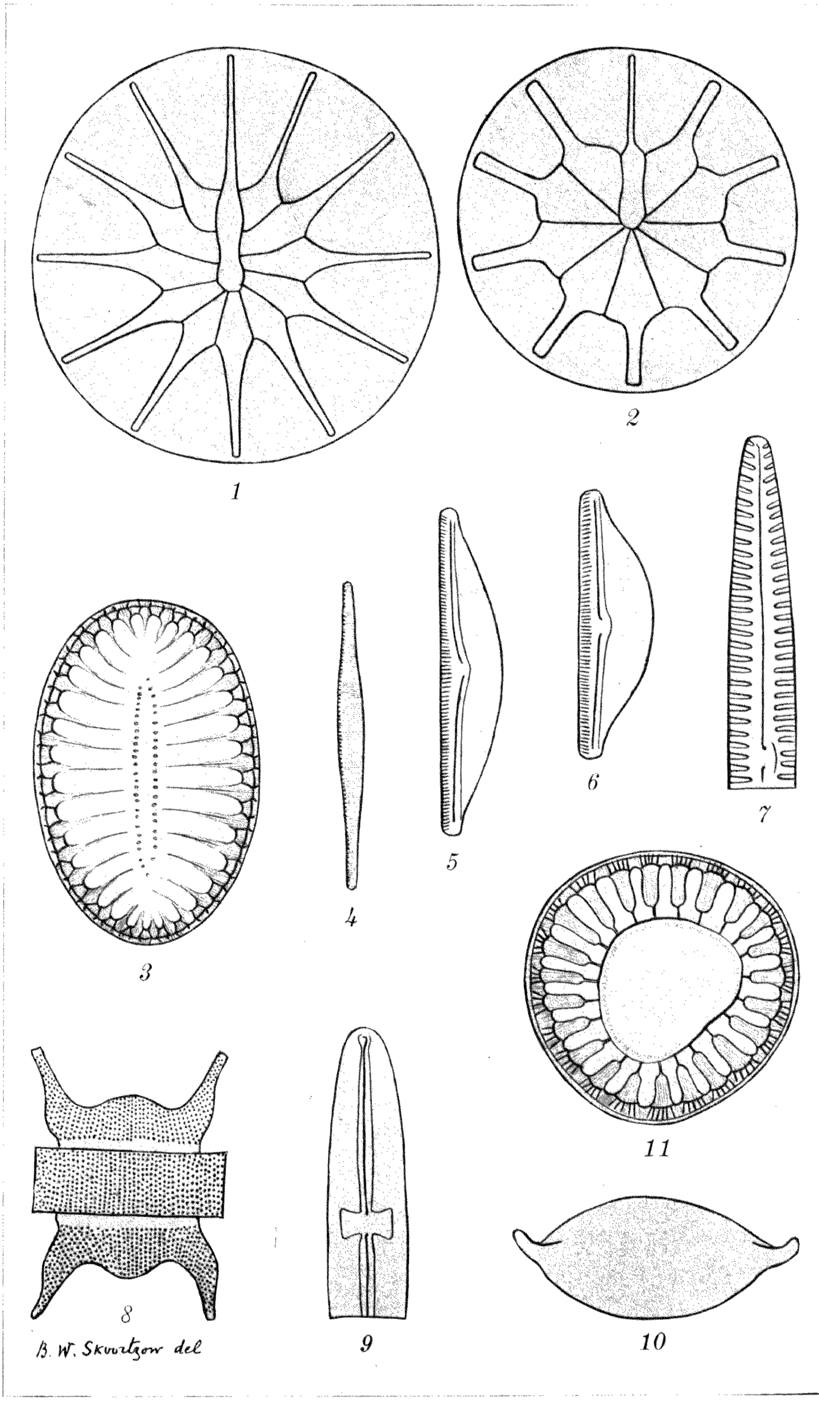

PLATE 4.

ANALYSIS OF SECTIONS OF SMALL AND MEDIUM-SIZED PHILIPPINE BAGTIKAN TREES, PARASHOREA MALAANONAN (BLANCO) MERRILL

By F. M. YENKO, LUZ BAENS, and AUGUSTUS P. WEST
Of the Bureau of Science, Manila
and
H. M. CURRAN
Of the Bureau of Forestry, Manila

TWO PLATES

The Philippine bagtikan trees [*Parashorea malaanonan* (Blanco) Merrill] are widely distributed in the Philippines. This species is one of the most abundant in the Islands. Recently we analyzed sections of the sapwood, heartwood, and core of both small and medium-sized bagtikan trees. Corresponding sections of these two trees gave quite similar analytical results for the chief constituents. In selecting bagtikan trees for analysis it would seem that any sound mature tree, whether small or of medium size, should give average representative samples.

The bagtikan tree sometimes grows to a diameter of 180 centimeters. The wood is of the lauan type. It is moderately hard and heavy, of coarse texture and has a durability of type IV. It seasons well with little checking and warping and is easy to work.

Bagtikan is used for ceilings, floors, doors, boxes, barges, furniture, and also for general cheap and temporary construction. An account of the structure of bagtikan, local names, and general properties is given by Schneider.[1]

EXPERIMENTAL PROCEDURE

A description of the bagtikan trees from which our wood samples were obtained is given in Table 1. Cross section logs were cut from about the middle of each tree. Sections of the sapwood, heartwood, and core were made from these logs.

[1] Philip. Bureau of Forestry Bull. 14 (1916) 167.

These sections were then heated in an air bath at 60° for about a day to eliminate most of the moisture and prevent the growth of fungi.

TABLE 1.—*Description of small and medium-sized bagtikan trees.*[a]

Measurements.		Small tree.	Medium-sized tree.
Diameter	centimeters	35.2	92.0
Total height	meters	22.2	46.53
Clear length	do	12.35	19.5
Length of crown	do	9.85	22.8
Average width of crown	do	6.0	19.21
Altitude above sea level	do	110.0	150.0
Habitat		Open.	Open.

[a] The small tree was cut from a pure stand of bagtikan seedlings located near the offices of the division of forest investigation, Los Baños. These trees were estimated to be about 40 to 50 years old. The diameter of the small tree was measured at breast height. The medium-sized tree was cut inside the Makiling National Botanic Garden along the bank of Molawin River just above the water intake. The diameter of the medium-sized tree was measured just above the buttress.

Samples for analysis were prepared from these sections by filing with a rasp. The wood filings were sieved and the portion that passed an 80-mesh sieve but was retained by a 100-mesh sieve was used for the analysis.

In analyzing the wood samples we used the standard methods [2] adopted by the United States forest products laboratory. Madison, Wisconsin. For moisture, cold-water soluble, alkali soluble, ether and alcohol extracts, ash, and nitrogen we followed, in general, the methods given by Schorger.

The cellulose was determined by the Cross and Bevan method.[3] The apparatus used for chlorinating the wood samples was an ordinary desiccator that had two holes drilled in the top and also two holes in the side near the bottom. From a dropping funnel, hydrochloric acid was allowed to drop upon crystals of potassium permanganate contained in a filtering flask. The chlorine gas was conducted through a drechsel wash bottle containing sulphuric acid into the desiccator directly over the wood sample. Tap water was allowed to flow into the bottom of the desiccator through the lower hole in the side and to flow out from the other side hole which was somewhat higher. The flowing water absorbed the excess chlorine. After a three-

[2] Bray, M. W., Paper Trade Journ. 87 (1928) No. 25, 59. Schorger, A. W., Chemistry of Wood and Cellulose (1926) 505. Mayhood, S. A., Journ. Ind. Eng. Chem. 12 (1920) 873.

[3] Schorger, A. W., Chemistry of Wood and Cellulose (1926) 512.

minute interval the first chlorination was completed. The first stopcock was then turned and the excess chlorine in the generator was allowed to flow through two drechsel wash bottles containing sodium hydroxide solution. By turning the second stopcock a current of air entered the first hole in the top of the desiccator and after circulating through the desiccator passed through the second hole in the top and through a train of six wash bottles containing sodium hydroxide solution. The last wash bottle was connected to a vacuum pump. The excess chlorine gas was thus absorbed and not allowed to circulate in the laboratory.

When washing the cellulose, after the last bleaching with potassium permanganate and sulphurous acid, the cellulose was heated in water over a steam bath for two hours and filtered. This procedure was repeated until the filtrate gave a neutral reaction with methyl red. The cellulose thus obtained was found to be very white when dried at 105° C.

The lignin was determined by a modification of the method of Ost and Wilkening.[4]

The cellulose used for the determination of alpha-cellulose was prepared by the Cross and Bevan method. In following this method the cellulose was washed with hot water after the final bleaching with potassium permanganate and sulphurous acid. The cellulose was then transferred to a beaker and heated with water on a steam bath. It was again filtered and the washing process repeated until the filtrate gave a neutral reaction with methyl red. The cellulose was filtered through cheese cloth over a buchner funnel with the aid of suction. This procedure was found to be more advantageous than the use of an alundum filter cone, which appeared to absorb traces of acid. It was found that the presence of mere traces of acid in the cellulose gave a low result in the alpha-cellulose determination.

The determination of alpha cellulose was made according to the procedure given by Schorger. After adding the sodium hydroxide solution (17.5 per cent) and diluting at the end of a half hour, the mixture was centrifuged instead of filtered because the cellulose clogged the alundum filter and retarded filtration. After centrifuging, the hydroxide solution was decanted. The cellulose was then treated with NaOH solution (8 per cent) and once more centrifuged and decanted. After a further treatment in like manner with water and acetic acid

[4] Paper Trade Journ. **87** (1928) No. 25, 61.

(10 per cent) the cellulose was then filtered through a tared alundum crucible and washed with water until the filtrate was neutral to methyl red. This procedure was found to be very rapid and accurate.

In determining the hot-water soluble material, the sample was heated (reflux) for twelve hours instead of three.

The results of our analyses are recorded in Table 2.

TABLE 2.—*Analyses of sapwood, heartwood, and core of small and medium-sized bagtikan trees.*[a]

[Samples taken from middle section of tree.]

Constituent.	Small tree.			Medium-sized tree.		
	Sapwood.	Heartwood.	Core.	Sapwood.	Heartwood.	Core.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	4.81	2.37	7.34	6.48	6.49	7.60
Cold water soluble	1.98	1.58	1.61	2.98	0.36	0.40
Hot water soluble	4.05	1.75	2.58	7.20	6.94	1.10
Alkali soluble	13.05	11.32	12.72	11.74	13.92	8.52
Ether extract	0.51	1.74	2.53	0.54	1.30	0.77
Alcohol extract	2.32	2.55	3.03	3.11	1.82	1.65
Ash	0.84	1.02	1.08	0.93	0.97	1.08
Nitrogen	0.19	0.13	0.16	0.23	0.14	0.15
Cellulose	50.74	52.74	50.91	53.12	54.44	56.39
Ash in cellulose	0.49	0.87	0.82	0.68	0.65	0.53
Ash-free cellulose	50.25	51.87	50.09	52.44	53.79	55.86
Lignin	32.80	34.17	33.62	30.06	31.80	31.76
Alpha cellulose	77.36	80.00	74.75	79.42	76.98	79.05

[a] The percentages were calculated on a moisture-free basis. The percentages of alpha cellulose represent the amount of alpha cellulose determined in the pure cellulose. The small tree had a diameter of 35.2 centimeters and the medium-sized tree 92 centimeters.

RESULTS

As shown by the data (Table 2) the percentage of alpha cellulose in each tree was very high.

The sapwood, heartwood, and core of the small tree gave a slightly higher percentage of lignin and a slightly lower percentage of cellulose than the corresponding sections of the medium-sized tree.

Both the small and medium-sized tree gave approximately the same percentage of nitrogen and ash. Results with extractives were quite different for the two trees.

In selecting bagtikan trees for analysis it would seem from our results that any sound mature tree, whether small or of medium size, should give average representative samples.

TABLE 3.—*Relation of total extractives to cellulose and lignin.*[a]

Constituent.	Small tree.			Medium-sized tree.		
	Sap-wood.	Heart-wood.	Core.	Sap-wood.	Heart-wood.	Core.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Total percentage of extractives	21.91	18.94	22.47	25.57	24.34	12.44
Cellulose	50.25	51.87	50.09	52.44	53.79	55.86
Lignin	32.80	34.17	33.62	30.06	31.80	31.76

[a] The total percentage of extractives represents the cold- and hot-water and alkali-soluble extracts and also the alcohol and ether extracts.

In Table 3 is given a comparison of the total percentage of extractives with the percentages of cellulose and lignin. As shown by the data, the sapwood of the small tree contains a larger percentage of extractives than the heartwood. The percentage of cellulose and lignin in the sapwood of the small tree is smaller than the corresponding percentages in the heartwood. It appears that a section, which has a higher percentage of extractives than another section, usually has a lower percentage of cellulose and lignin. In comparing other sections of these bagtikan trees similar results are obtained. The excess of a particular constituent in a section seems to be balanced by a deficit in other constituents. Somewhat similar results were obtained in the analysis of the sapwood and heartwood of American trees.[5]

SUMMARY

Sections of the sapwood, heartwood, and core of a small and of a medium-sized bagtikan tree were analyzed. Corresponding sections of these two trees gave quite similar results for the chief constituents.

In selecting bagtikan trees for analysis it would seem that any sound mature tree, whether small or of medium size, should give average representative samples.

[5] Ritter, G. J., and L. C. Fleck, Journ. Ind. Eng. Chem. 15 (1923) 1055; 18 (1926) 576.

ILLUSTRATIONS

PLATE 1

FIG. 1. Apparatus for chlorinating wood samples.
2. A group of young bagtikan trees.

PLATE 2

An old bagtikan tree.

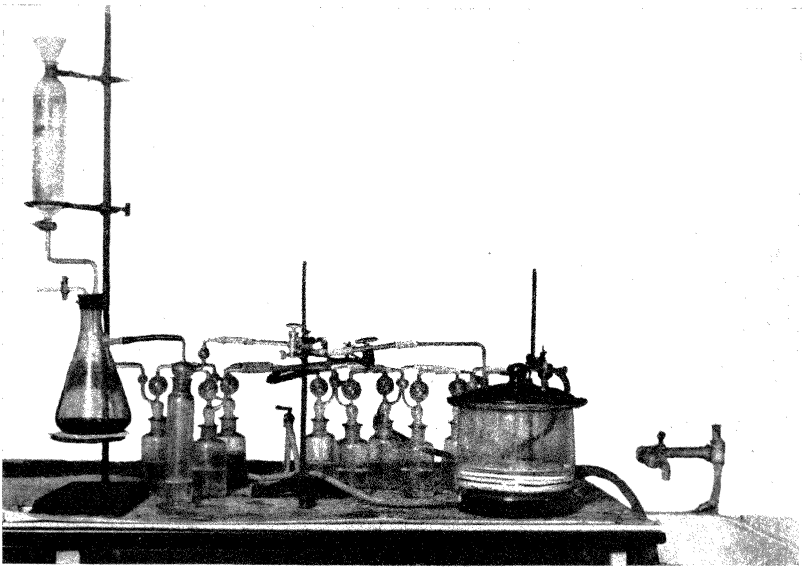

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PLATE 1.

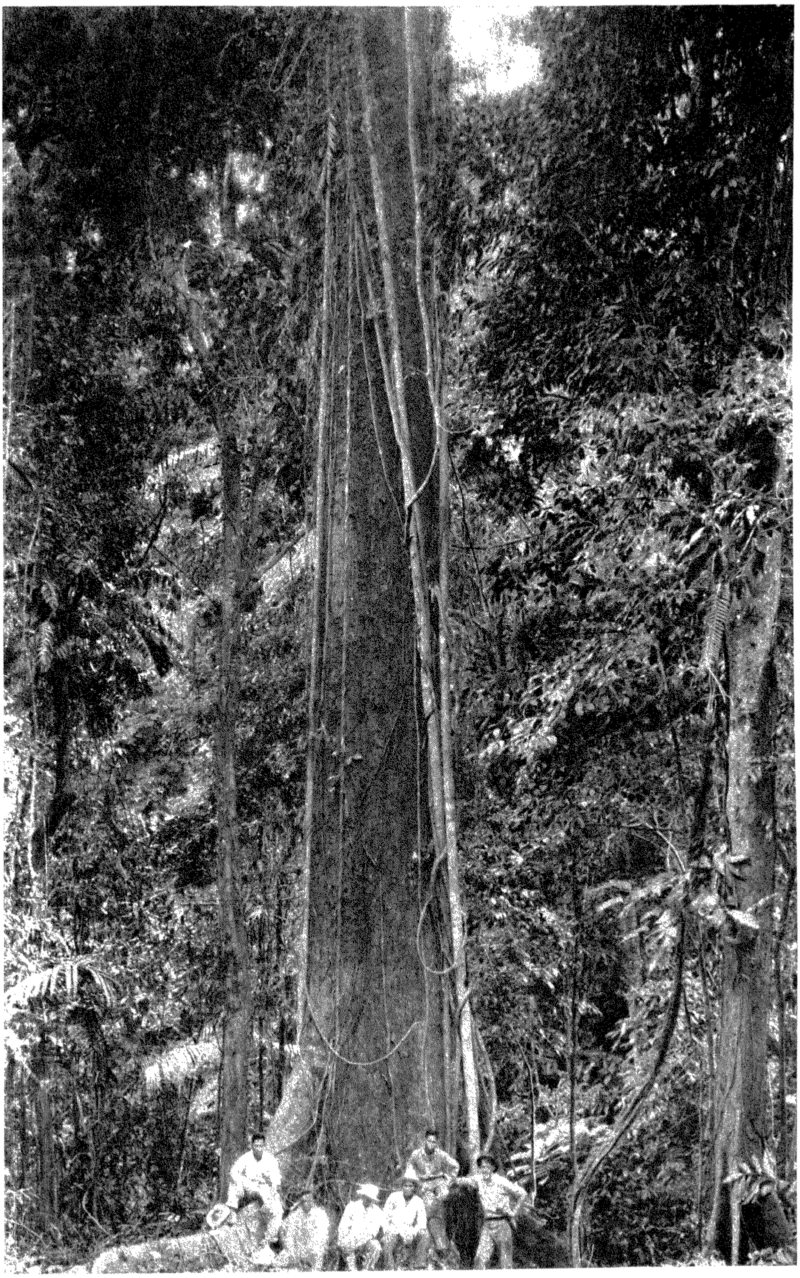

PLATE 2.

TWO NEW SPECIES OF SOOTY MOLDS FROM THE PHILIPPINES

By JOSÉ M. MENDOZA

Associate Mycologist, Bureau of Science, Manila

TWO PLATES

The sooty molds constitute the family Capnodiaceæ. In the Philippines, these fungi are of common occurrence and usually form a dense black coating on the surface of leaves, stems, branches, and fruits. They are always associated with species of woolly aphis or may occur on the droppings from these insects. They are more prevalent during the rainy season, and although they produce no appreciable ill effect upon the host, the photosynthetic activity of the plant is undoubtedly very much reduced.

The two following new species were noted while looking over a large number of undetermined ascomycetes which have accumulated at the Bureau of Science during the past decade or more.

SCORIAS PHILIPPINENSIS sp. nov.

Fungous colony amphigenous, but more abundant on the upper surface. Mycelium perisporoid, slimy, closely interwoven, weftlike, straw-colored to dark brown. Perithecia stalked, abundant, ovate or pyriform, obtuse or acuminate, seated on the fibers of the mycelium, 100 to 159 by 82 to 130 μ, greenish black; texture cellular-subradiate. Asci numerous, obovate to clavate, thick-walled, 8-spored, 40 to 57 by 12 to 13 μ; aparaphysate. Spores hyaline, cylindrical, tapering at one end, 3-septate, 21 to 23 by 3 to 4 μ. Pycnidia numerous, cylindrical, highly variable in size, 40 to 528 by 13 to 26 μ (Plate 1).

On *Ficus hauili*, Batangas Province, Luzon, Philippine Islands, *M. Ramos and Deroy, Bur. Sci. 22672* (type), April or May, 1915.

This species falls under *Scorias* Fries,[1] in having generic characteristics which are identical with it, or very nearly so. The type species is *Scorias spongiosa* (Schw.) Fr.[2] and is found in

[1] Syst. Orb. Veg. 1 (1825) 171.

[2] Ellis and Everhart, North American Pyrenomycetes (1892) 55, pl. 10, fig. 1.

North America. My fungus agrees in many respects with the description of the type; it differs, however, in having very much larger perithecia, pycnidia, asci, and ascospores. It differs also from *Scorias paulensis* P. Henn.[3] in the number of spores in the ascus; *S. paulensis* has 4-spored asci, while *S. philippinensis* has 8-spored ones. *Scorias capitata* Sawada[4] also differs from *Scorias philippinensis* in having 6- to 8-spored asci, while the species here described has only- 8-spored ones. The spores in *S. capitata* are obtuse at both ends; in *S. philippinensis* they taper at one end and round at the other.

PARASCORIAS SPINOSA sp. nov.

Fungus colony strictly epiphyllous. Mycelium dematioid, superficial, very gelatinous, from amber to dark brown in color, provided with blunt coarse spines, composed of much constricted, usually rounded but occasionally more or less cylindrical, cells; the rounded ones 3.2 to 11.5 μ in diameter, the cylindrical ones 8.0 to 9.6 μ long, 3.5 to 6.4 μ wide; mycelial branches tapering toward the end. Perithecia ostiolate, occasionally oval but generally almost cylindrical, very gelatinous, basal membrane composed of beaded mycelium, 60 to 143 by 41 to 47 μ. Asci numerous, cylindrical to club-shaped, thick-walled, 8-spored, 47.8 to 57.5 μ long, 15.5 to 16.5 μ wide; aparaphysate. Spores hyaline, cylindrical, tapering at one end, 1-septate, 14 to 16 μ long, 3 to 4.3 μ wide. (Plate II.)

On *Smilax* sp., Bucas Grande Island, Philippine Islands, *M. Ramos and J. Pascasio, Bur. Sci. 35931* (type), June, 1919.

This species falls under the genus *Parascorias* Mendoza.[5] The type of the genus is *Parascorias byrsonimae* Mendoza. The new Philippine species, although similar in many characters to *Parascorias byrsonimae,* which came from British Guiana, differs from it in having a mycelium provided with blunt and coarse spines, and is very gelatinous. The perithecia in *Parascorias byrsonimae* are globular to oval in shape while in *Parascorias spinosa* they are occasionally oval, but usually cylindrical, and very much larger. The asci in *Parascorias spinosa* are cylindrical or club-shaped, and are larger and much thicker than in *Parascorias byrsonimae,* in which they are ovate. The specific name has reference to the spiny character of the mycelium.

[3] Hedw. 48 (1908) 6.

[4] Nôjshikenjô Tekubet su Hôkoku (Special report, Agr. Exp. Sta.) Taiwan (Formosa), No. 11 (Feb., 1915) 123–124, pl. 4, figs. 19–23, T. 4, ii (Japanese).

[5] Ann. Mycol. 28 (1930) 366.

In addition to the two new species described above another interesting one was found among the Bureau of Science material. This was *Antennellina hawaiiensis* Mendoza, on leaves of *Ficus* sp., vicinity of Tangkulan, Bukidnon Subprovince, Mindanao, Philippine Islands, *E. Fenix, Bur. Sci. 26179,* July, 1916. The characteristics of the Philippine specimen are all identical with those of the type from Hawaii.[6]

ACKNOWLEDGMENT

The writer wishes to acknowledge the services of Dr. C. J. Humphrey, mycologist in charge of investigations in mycology and plant pathology, Bureau of Science, in reviewing the work and assisting in the preparation of the manuscript.

[6] Bernice P. Bishop Mus. Bull. 9 (1925) 55.

ILLUSTRATIONS

PLATE 1. SCORIAS PHILIPPINENSIS SP. NOV.

FIG. 1-a, 1-b. Pycnidia showing variable sizes.
2. Perithecium with ostiole and mycellum.
3-a, 3-b. Asci with eight ascospores.
4. Ascospores showing septation.
5. Mycelium showing characteristics of cells.
6. Photomicrograph of fungous colony.
7. Upper and lower surfaces of a leaf showing the presence of the fungus.

PLATE 2. PARASCORIAS SPINOSA SP. NOV.

FIG. 1. Perithecium showing ostiole and a portion of the beaded mycelium.
2. An ascus with 8 spores.
3. Three ascospores.
4a, 4b. Photomicrograph and drawing of a portion of the mycelium showing spines.
5. Photomicrograph of fungous colony.
6. Upper and lower surfaces of infected leaves.

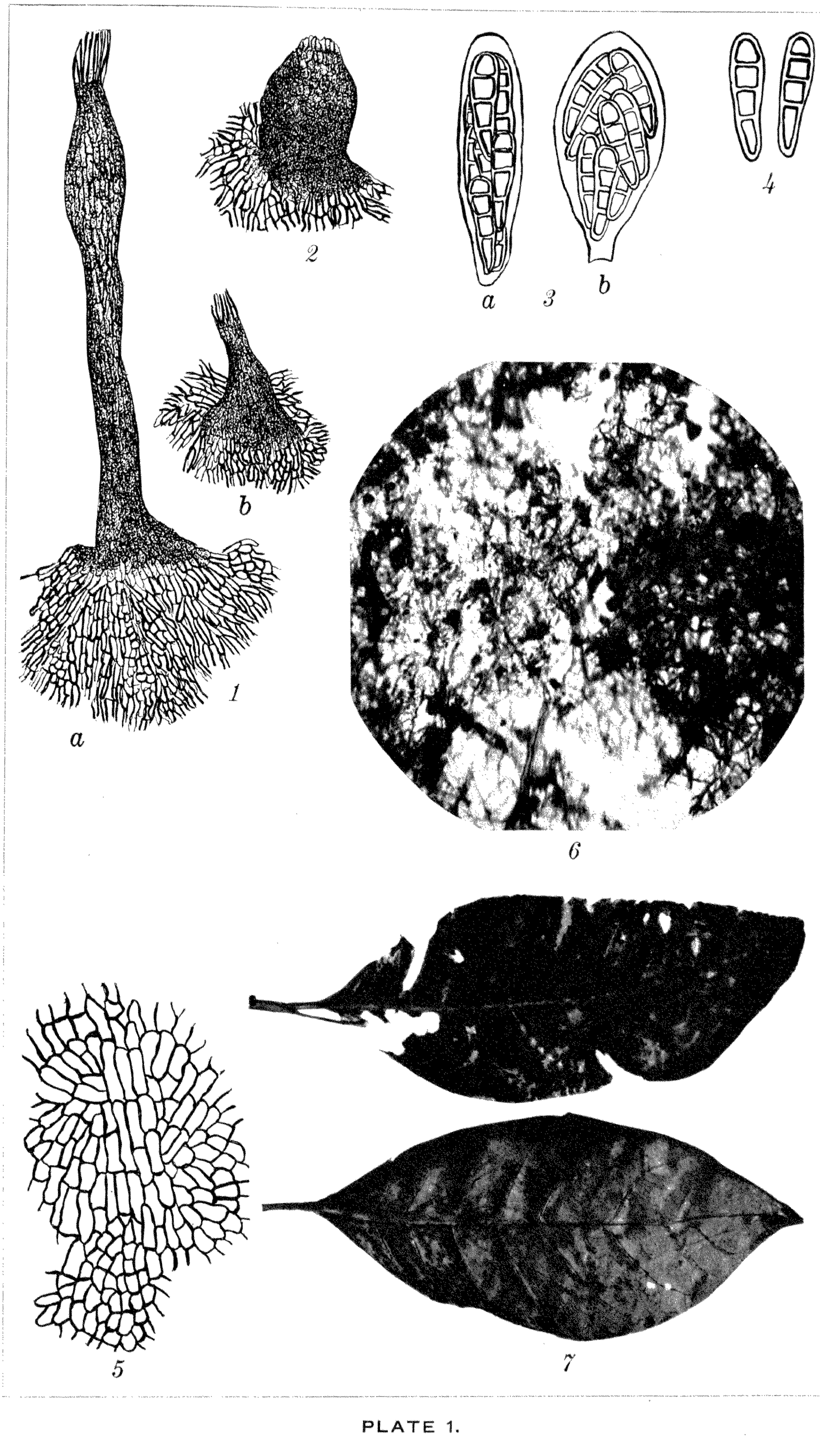

PLATE 1.

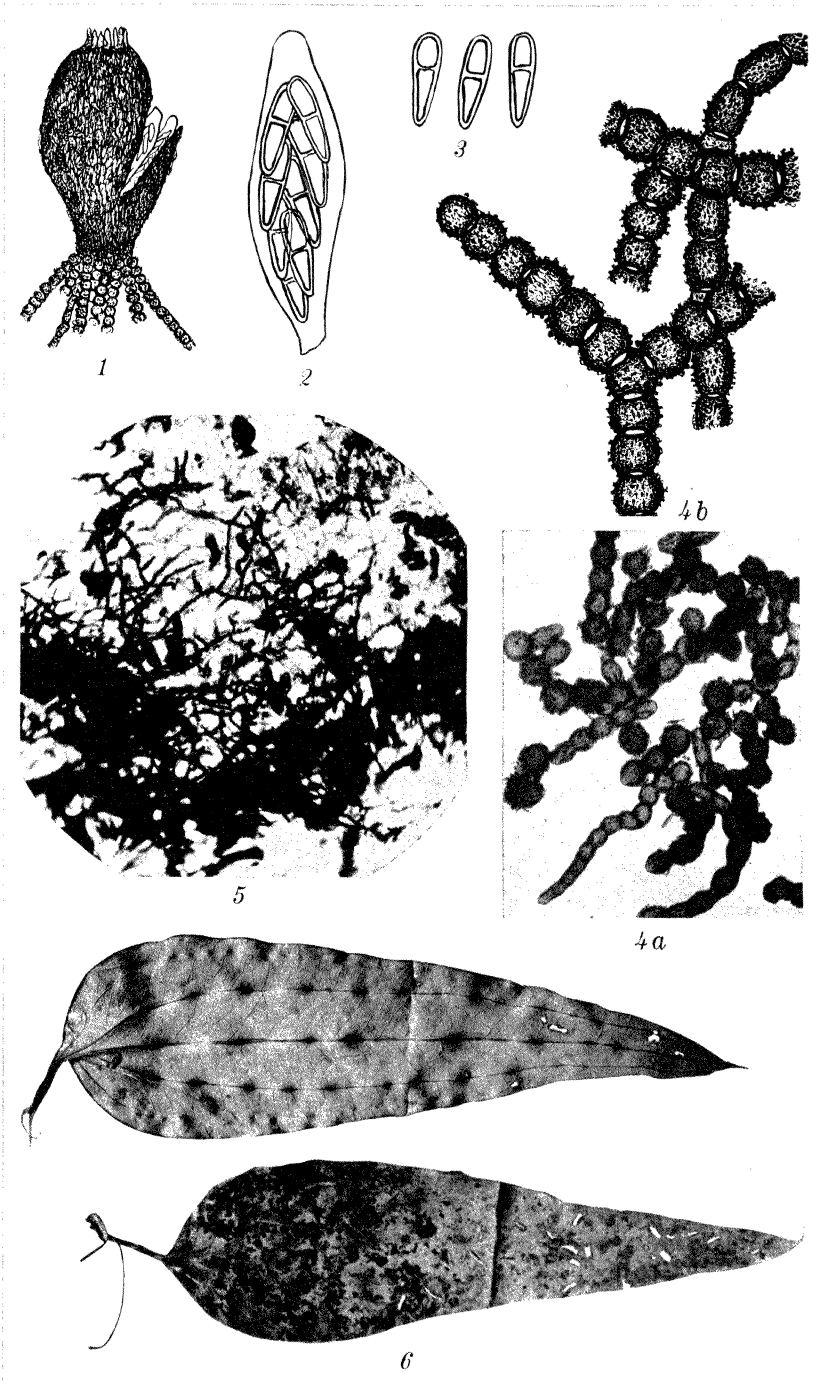

PLATE 2.

THE LATICIFEROUS VESSELS AND OTHER ANATOMICAL STRUCTURES OF EXCŒCARIA AGALLOCHA

By José K. Santos

Of the Department of Botany, University of the Philippines and of the Bureau of Science, Manila

FOUR PLATES

The main object of this brief investigation is to gain information concerning the nature and the distribution of the laticiferous vessels of *Excœcaria agallocha* Linnæus, and incidentally to have a description of the anatomical structures of its bark and leaf, where these latex tubes are located.

Excœcaria agallocha, locally known as *buta-buta* or *alipata,* is a shrub or small tree, of the well-known family Euphorbiaceæ, found distributed throughout the Philippine Archipelago along the seashore or within the influence of salt or brackish water. Practically all parts of this plant yield an acrid milky juice derived from the laticiferous vessels. This juice is so acrid, especially when fresh, that it blisters the skin, and when it gets into the eyes it produces intense pain and eventually blindness. In fact in India, where this plant also occurs, it is called the "blinding tree." In Malaya, according to Gimlette(2) the milky juice from buta-buta is administered internally as a poison by mixing it with the blood of the flying fox, the concoction producing strangury with hæmaturia and violent inflammation of the intestines. Dymock(1) states that in Australia and New Guinea, the milky juice obtained from the bark, when green, is used to cure ulcers, leprosy, etc. As far as the available literature is concerned the morphology of the laticiferous vessels of buta-buta, in which this poisonous acrid milky juice is lodged, and the anatomical structures of its bark and leaf have never been described. A brief study of these parts of the plant, therefore, is desirable not only for purely morphological reasons, but also in order to form a basis for the identification of the plant or parts of it in case of poisoning.

MATERIAL AND METHODS

The bark and leaves of *Excœcaria agallocha* used in this study were collected from Binauañgan, Bulacan Province, by Maximo

Ramos, a collector of the Bureau of Science. In March, 1931, he was sent to that place by Dr. Leon Ma. Guerrero, chief of the division of botany, Bureau of Science, to gather specimens of the bark and leaves of buta-buta for chemical analysis. A few pieces of bark and some leaves of this material were given to the author for this investigation.

Several transverse, radial, and tangential sections of the bark varying in thickness from 20 to 35 microns were prepared by means of a sliding microtome. The cells of these sections were found to have walls of a brownish color, and some had brownish contents. It was decided, therefore, to study them without staining. Some were simply mounted in water and examined, and others were mounted in dilute glycerine.

A portion of the bark was cut into small blocks about 1 centimeter long and 0.5 centimeter wide and macerated with warm 2 per cent solution of sodium hydroxide for one or two hours. The pieces of bark were washed thoroughly and the laticiferous vessels were carefully dissected, treated with solution of iodine, examined, and drawn. Several transverse sections through the midrib and surface preparations of the leaf were also made. These sections, like those of the bark, were examined in water and glycerine mount only without staining them.

THE BARK

The bark when dry is from 1 to 4 millimeters in thickness, and is either partially quilled with the two sides slightly rolled inward or overlapping quilled (Plate 2, fig. 9, *a–d*). Externally it is smooth or rough with numerous brown, rounded, axially or tangentially elongated lenticels. The color is grayish brown or greenish brown with some white patches of lichens or sometimes with some green algæ. Occasionally, some dark glistening resinous strips are observed on the outer surface. These resinous strips are due to dried latex exuded during the preparation of the bark. The periderm is thin and in some places near the edges of the bark it separates from the cortex. The inner surface is from light brown to dark brown or sepia color. It is smooth and finely striated longitudinally. The bark is strong and fibrous and bends when pressure is applied. The odor is not characteristic. The taste is slightly bitter and acrid.

Microscopical structure.—The external part of a transverse section of the bark is invested by a periderm which consists of two distinct regions; namely, the outer region or corky region,

and the inner region or phellogenetic region. The outer region is composed of several layers of thin-walled, suberized, and tightly compressed or tangentially flattened cells with a brownish substance in their small cavities. The inner region is built up of from 15 to 20 layers of empty, thin-walled, tangentially elongated and radially arranged phellogenetic cells. They are arranged more or less in concentric rows and are hyaline in character. Plate 3, fig. 10, represents a segment through the periderm showing the two distinct regions just described. The phellogen is distinct. The cortex is not sharply limited from the pericycle by a starch sheath. It is made up of several layers of tangentially elongated and irregularly arranged cells, most of which are filled with a brownish resinous substance (Plate 3, fig. 11, and Plate 4, fig. 28). Intermingled with these cortical parenchyma cells are some elliptical or rounded and usually larger structures. These are laticiferous vessels (Plate 3, fig. 16.) They are quite similar in general appearance to the parenchyma cells but are readily distinguished from the latter by their granular grayish content. Plate 3, fig. 11, shows a segment through the inner portion of the periderm and cortex, in which the characters of the cortical parenchyma cells and the laticiferous vessels are indicated. The pericycle consists mostly of parenchyma cells and a few slender bast fibers with thin and unlignified cell walls, hence it is not conspicuous (Plate 3, fig. 12). Scattered throughout the pericycle region there are also some laticiferous vessels. The bast region represents about one-third of the entire section. It is characterized by the presence of numerous uniseriate medullary rays that are distributed at intervals of almost every four cells. This region is composed primarily of phloëm cells, parenchyma, and laticiferous vessels. Towards the periphery some of the phloëm cells are often found collapsed into strands in which their outline and cell cavities are greatly deformed, and their identity is lost (Plate 3, fig. 12). Towards the cambial region, however, the phloëm cells are either polygonal or rectangular in outline (Plate 3, fig. 13). Intermingled with them are phloëm parenchyma cells that are very similar in appearance to the sieve tubes in cross section. Occasionally some of the parenchyma cells are found to contain prismatic calcium oxalate crystals (Plate 3, fig. 17). The laticiferous vessels are rather conspicuous in this region. They are either found mixed with the phloëm cells or between the medullary-ray cells as illustrated on Plate 3, fig. 13. The medullary rays are one cell wide and the medullary-ray cells are either

empty or filled with a resinous brownish substance. Occasionally some medullary-ray cells contain prismatic or cubical calcium oxalate crystals. Plate 3, fig. 15, is a segment of a medullary ray with two cells containing a round brownish resinous substance, and on the same plate, fig. 18, is another segment of a medullary ray showing two cells containing crystals of calcium oxalate.

In the longitudinal section of the bark, the elements of the periderm, as in the cross section, are differentiated into two regions, the cells of the outer region being suberized and filled with a brownish substance and those of the inner region being hyaline. The cortical parenchyma is likewise not sharply limited from the pericycle by a starch sheath, and most of the cortical parenchyma cells, as in the cross section, are filled with the brownish substance. Very often between the cortical parenchyma cells are laticiferous vessels which run parallel to each other. Bast fibers are occasionally observed. They are few and very long, measuring about 2.2 millimeters in length (Plate 4, fig. 29). The bast region is characterized by the numerous laticiferous vessels and by the one-cell wide medullary cells that are mostly filled with a brownish substance. The phloëm parenchyma cells are likewise mostly filled with the same substance or in some cases they are filled with solitary, monoclinic or prismatic calcium oxalate crystals forming a crystal fiber (Plate 4, fig. 27). Plate 3, fig. 14, represents a segment of the longitudinal section through the bast showing the parallel arrangement of the laticiferous vessels, the characters of the medullary cells, the phloëm parenchyma with brownish substance contents, the crystal fiber, and the relative position of the sieve tubes.

Anatomical structure of the leaf.—The lamina in a thin transverse section exhibits some interesting features. It is bifacial and about 0.8 millimeter thick. In its upper part it is limited by two layers of cells, the outer or upper layer being the epidermis and the lower layer the hypodermis. The outer epidermal cells are rectangular in shape with thick outer walls. The hypodermal cells are also rectangular in outline, but are slightly larger and have thinner walls on the outer as well as on the inner side (Plate 1, fig. 8, and Plate 4, fig. 24). The occurrence of this extra layer of cells on the upper part of the leaf in *Excœcaria agallocha,* according to Solereder,(6) was first observed by Herbert, who also noted that it occurs in species of various euphorbiaceous genera. On the lower part the thin section of

the lamina is bounded by a single layer of rectangular epidermal cells, the outer walls of which are thick, but comparatively thinner than those of the upper epidermal cells. The mesophyll is distinctly differentiated into palisade and spongy regions. The palisade region occupies about one-half of the upper part of the mesophyll. It consists of two layers of tubular palisade-chlorenchyma cells. The cells of the upper layer are twice as long as those of the lower layer. The lower or spongy region is built up of rounded, slightly elongated or irregularly shaped spongy-chlorenchyma cells supplied with rich air spaces. The veins or veinlets are embedded towards the upper part of this region. In these veins usually one or two laticiferous vessels are found intermingled with the phloëm cells or with the border parenchyma. Calcium oxalate crystals in rosette, cubical, or prismatic form are also observed lodged in some of the parenchyma cells on the outer part of the veins. They are sometimes found in rows in the longitudinal sections forming a crystal fiber (Plate 4, figs. 24 and 27).

The upper epidermis in surface view is composed of cells varying from 0.04 to 0.07 millimeter in length and from 0.02 to 0.04 millimeter in diameter. These epidermal cells are polygonal in outline with straight or slightly wavy, thick walls (Plate 4, fig. 25). The lower epidermis in the surface preparation is also built up of polygonal cells from 0.03 to 0.07 millimeter long and from 0.01 to 0.035 millimeter in diameter. Their walls are thinner than those of the upper epidermal cells, but they are also either straight, slightly bent, or faintly wavy. The stomata are large and numerous. They measure from 0.035 to 0.055 in length and from 0.025 to 0.035 millimeter in width, and are confined to the lower epidermis. The stomata are characterized by being accompanied on either side by one or more subsidiary cells that are pressed parallel to the pore. The integumental outgrowth is absent on either surface of the leaf (Plate 4, fig. 26). Another important feature of the leaf in the surface preparation of the epidermis is the occurrence of fine striation in the cuticle. This striation of the cuticle is observed only on the surface of the lower epidermal cells and is wanting on the surface of the upper epidermis. The striated lines run in various directions and usually emerge or radiate from the two sides of the different stomata.

A transverse section through the midrib reveals that the upper part is almost flat or very slightly convex, and the lower part is convex or rounded (Plate 1, fig. 8). The upper and

lower epidermal cells are nearly square or rectangular in outline or in some cases radially elongated. They are comparatively narrower or smaller than those of the blade (Plate 4, fig. 20 and 21). The hypodermis on the upper surface of the blade is not extended over the midrib. The upper collenchyma region consists of two or three layers of cells and occupies the upper portion of the midrib. The inner part is bounded by the cortical parenchyma. The lower collenchyma region is composed of three or four layers of thick-walled cells extended from one side of the midrib to the other, forming a sort of bandlike structure along the inner side of the lower epidermis. The collenchyma cells of both regions possess intercellular spaces. Very often collenchyma cells are observed to contain a resinous substance, and sometimes one or more laticiferous vessels are found mixed with them. The cortical parenchyma regions in the upper and lower parts of the meristele are composed of large, rounded or polygonal, thin-walled parenchyma cells with some intercellular spaces. Intermingled with these cells are some laticiferous vessels. The cortical parenchyma at the two lateral sides of the meristele are built up of small polygonal and thin-walled cells with or without intercellular spaces. On the other hand the parenchyma cells of the central portion of the midrib are either rounded or polygonal and have the general characteristics of the cortical parenchyma cells. The endodermis is not distinct and the sclerenchymatous elements are wanting. The meristele is divided into an upper and a lower region. The upper region is usually divided into four vascular bundles usually arranged in a horizontal position. The lower region is somewhat crescent-shaped and occupies a larger space. The phloëm consists of small, thin-walled sieve tubes and companion cells, and sometimes at intervals large parenchyma cells and laticiferous vessels are observed (Plate 4, fig. 23). The xylem is composed of vessels arranged regularly in radial rows. Between these rows are thin-walled and radially elongated parenchyma cells or medullary-ray cells.

The laticiferous vessels.—In connection with the course of development of the laticiferous vessels of members of the various tribes of the Euphorbiaceæ, according to Solereder,(6) Hanstein and Chauveaud have shown that these vessels are differentiated at a very early stage in the plane of the cotyledonary node, their initial cells being situated in the outermost cell layer of the central cylinder. These initial cells either compose the whole of this layer, or they are arranged in it in the form of four arcs.

Petch(4) states, however, that in *Hevea* and *Manihot* the laticiferous vessels are formed from rows of special cells, which are especially laid down by the cambium as latex cells. The cross walls that separate the cells are absorbed, and in this way a continuous tube is produced. This process is followed by the absorption of the lateral walls between two vertical rows of cells, so that the tubes communicate with one another laterally, resulting in the reticulate arrangement of the laticiferous vessels. In the case of *Excœcaria agallocha* there are no rows of special cells developed by the cambium that give rise to laticiferous vessels, nor is there a single latex tube observed that shows any sign of articulation. Its laticiferous vessels appear as continuous and independent tubes about 0.06 millimeter in diameter. These tubes branch occasionally and run more or less parallel through the cortical and bast regions of the bark, but they are especially numerous in the latter. They intermingle with the phloëm cells. In cross section, without their latex content, they appear very similar to the sieve tubes or perenchyma cells, but they are usually larger in size, have slightly thicker walls, and their granular and grayish latex readily distinguish them. However, in the longitudinal sections they are quite conspicuous and consist of continuous long tubes somewhat similar to those found by the writer(5) in the bark of *Alstonia scholaris*. They are either somewhat straight or crooked without a trace of articulations, as represented on Plate 3, figs. 14 and 19, *a-c*.

The latex tubes are also found quite abundant in the midrib and veins. In the former they are distributed in the cortical parenchyma, bast, and pith, while in the latter, they are simply mixed with phloëm cells and are less numerous, usually one or two only in each vein.

The latex content of the laticiferous vessels of *Excœcaria agallocha* consists of a milk-white liquid which, according to Hooper,(3) has an acid reaction and an odor like that of sour milk, mixes freely with water, coagulates below the boiling point, and precipitates when spirit is added. The specific gravity of the latex determined by him at 15° C. was 1.0718, and its chemical composition is as follows: Water, 61.94 per cent; resin, 28.85 per cent; soluble in water, 1.76 per cent; albumin soluble, 3.40 per cent; albumin insoluble, 4.05 per cent.

SUMMARY

1. In the bark, the laticiferous vessels of *Excœcaria agallocha* are scattered throughout the entire region except in the peri-

derm. They run more or less parallel to each other in the cortical and bast region of the bark, but are especially numerous in the latter.

2. In the leaf, the latex tubes are found quite abundant in the midrib and veins. In the midrib they are distributed in the cortical parenchyma, bast, and pith, while in the veins they are found mixed with the phloëm cells or with the border parenchyma.

3. The periderm is differentiated into two regions; the cells of the outer region are suberized, but those of the inner region are not.

4. The cortex is thin and not sharply limited from the pericycles by starch sheath.

5. The pericycle is not conspicuous and consists mostly of parenchyma cells and a few long bast fibers.

6. The bast region is traversed by one-cell wide medullary rays and most of the medullary cells contain a resinous brownish substance or solitary calcium oxalate crystals.

7. The leaf in cross section is bifacial and characterized by the presence of a single layer of hypodermal cells.

8. The stomata are confined to the lower surface and are characterized by being accompanied on either side by one or more subsidiary cells that are pressed parallel to the pore.

9. The cuticle of the lower epidermis in the surface preparation is characterized by fine striations which usually radiate from the two sides of the stomata.

10. The cross section of the midrib is almost flat above and convex below. The meristele is divided into two regions; namely, the upper region, consisting usually of four vascular bundles; and the lower region, which is more or less crescent-shaped.

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ILLUSTRATIONS

PLATE 1. EXCŒCARIA AGALLOCHA LINNÆUS

FIG. 1. Habit sketch of a portion of the plant, bearing male inflorescence; × 0.5.

2. Another habit sketch of a portion of the plant, bearing female inflorescence; × 0.5.
3. A sketch of a single leaf showing an irregular margin; × 0.5.
4. A young inflorescence; × 1.5.
5. A mature male inflorescence; × 1.
6. A small portion of the male inflorescence, showing the character of the anthers protected by bracts at the base; × 5.
7. A small portion of the female inflorescence, showing the characters of the young ovaries with their bracts removed; × 4.
8. A diagrammatic sketch of the cross section of the leaf through the midrib, showing, *ue*, upper epidermis; *h*, hypodermis; *pc*, palisade chlorenchyma; *s*, spongy chlorenchyma; *le*, lower epidermis; *c*, collenchyma; *uc*, upper conducting tissue; *lc*, lower conducting tissue; *lv*, laticiferous vessels; *rs*, resinous substance; *p*, parenchyma; × 25.

PLATE 2. EXCŒCARIA AGALLOCHA LINNÆUS

FIG. 9. Photograph of the dried bark.

PLATE 3. EXCŒCARIA AGALLOCHA LINNÆUS

FIG. 10. A segment of a transverse section through the outer portion of the periderm; *k*, cork cells; × 165.

11. A segment of a transverse section through the cortical region and a portion of the inner part of the periderm; *p*, phellogen; *lv*, laticiferous vessels; *rs*, resinous substance; × 165.
12. A segment of the transverse section through the inner portion of the pericycle and the outer part of the bast; *lv*, laticiferous vessels; *ph*, phloëm; *bf*, bast fiber; × 165.
13. A segment of a transverse section through the inner part of the bast, showing *m*, medullary rays; *lv*, laticiferous vessels; *ph*, phloëm; *rs*, resinous substance; × 165.
14. A segment of the longitudinal section through the bast, showing *lv*, laticiferous vessels; *co*, calcium oxalate crystals; *rs*, resinous substance; *m*, medullary ray cells; *st*, sieve tube; *phj*, phloëm parenchyma; × 165.
15. A segment of a transverse section through the medullary rays; *rs*, resinous substance; × 700.
16. A segment of a cross section cut through the cortical region; *lv*, laticiferous vessels; × 700.

FIG. 17. Two solitary calcium oxalate crystals from the phloëm parenchyma cells; × 700.

18. A segment of the medullary ray from a transverse section of the bark; *co*, calcium oxalate crystal; × 700.

19. Isolated laticiferous vessels drawn from the macerated section of the bark, *a–c;* × 275.

PLATE 4. EXCŒCARIA AGALLOCHA LINNÆUS

FIG. 20. A segment of a transverse section through the upper cortical region and epidermis of the midrib; *c*, collenchyma cells; × 220.

21. A segment of a transverse section through the lower collenchyma region and epidermis of the midrib; *c*, collenchyma; *rs*, resinous substance; × 220.

22. A portion of the transverse section through the upper conducting tissue of the midrib; *ph*, phloëm; *x*, xylem; *lv*, laticiferous vessels; × 220.

23. A portion of the transverse section through the lower conducting tissue of the midrib; *lv*, laticiferous vessels; *x*, xylem; *ph*, phloëm; × 220.

24. A portion of a transverse section of the blade; *ue*, upper epidermis; *h*, hypodermis; *pc*, palisade chlorenchyma; *s*, spongy chlorenchyma; *co*, calcium crystals; *v*, vein; *le*, lower epidermis; × 60.

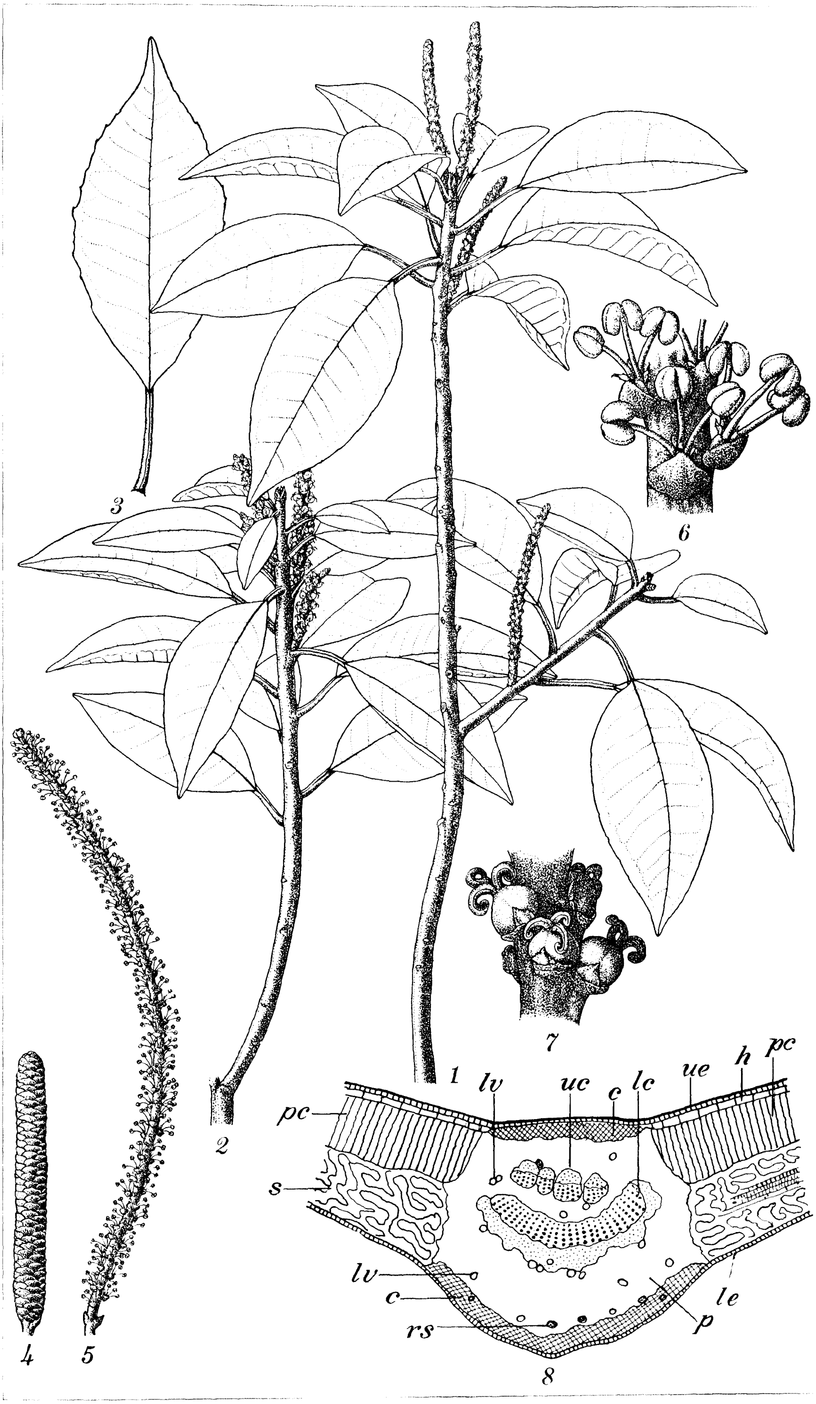
25. A small portion of a surface view of the upper epidermis; × 220.

26. A small portion of the surface view of the lower epidermis; *st*, stomata; × 220.

27. A crystal fiber; *co*, crystal of calcium oxalate; × 220.

28. Isolated parenchyma cells containing resinous brown substance, *a–c;* × 220.

29. Isolated bast fibers, *a–b;* × 220.



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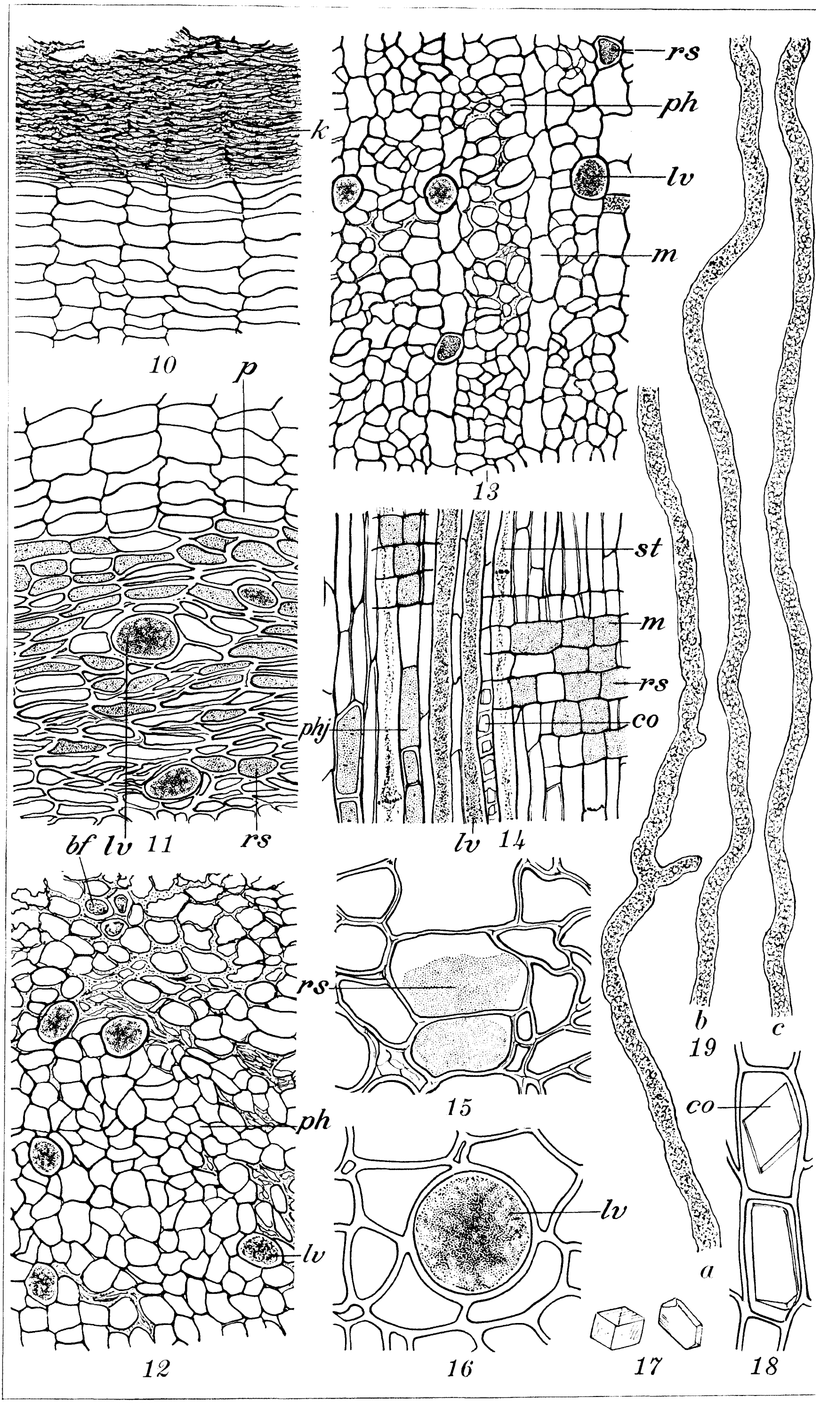
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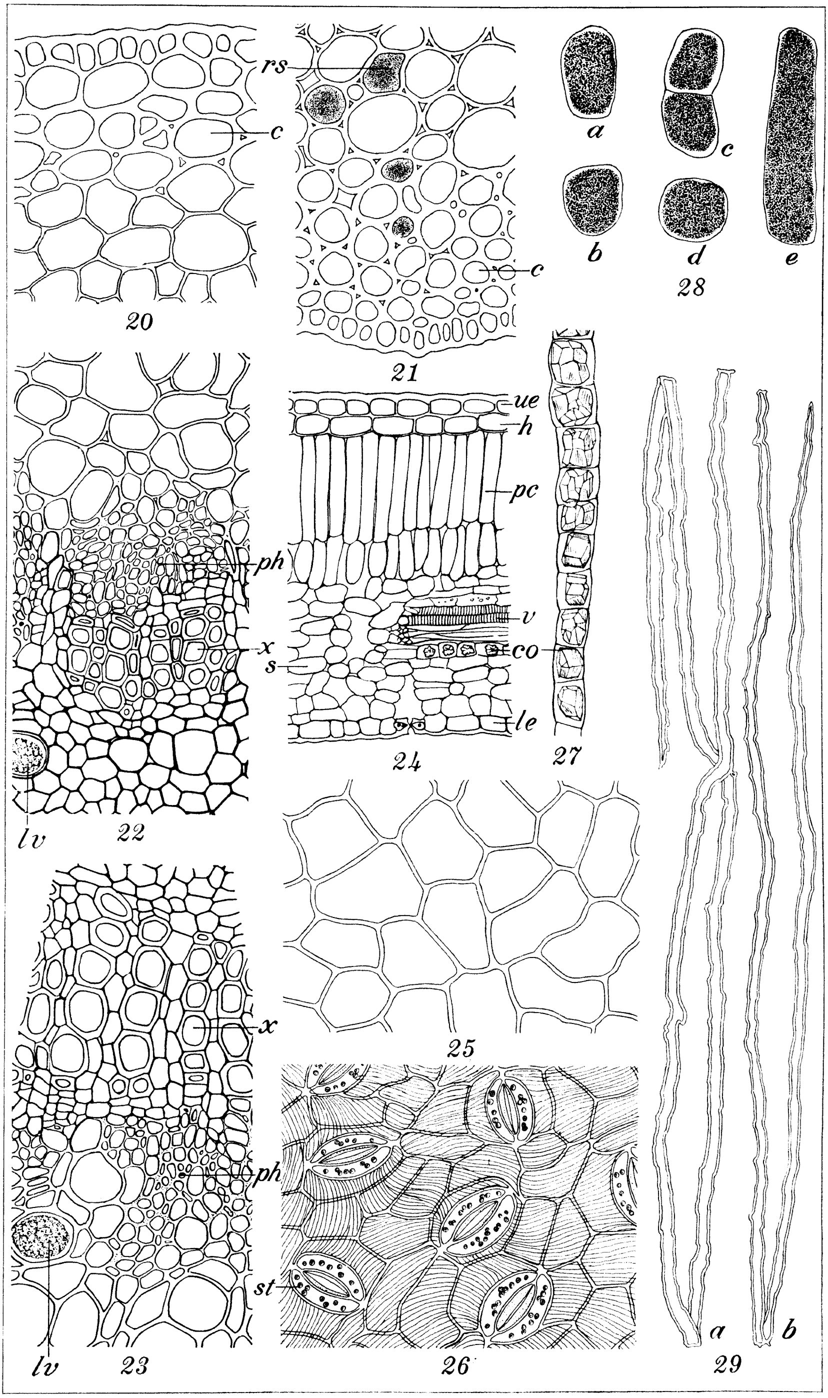
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PLATE 4.

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THE PHILIPPINE
JOURNAL OF SCIENCE

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THE PHILIPPINE ANOPHELES OF THE ROSSI-LUDLOWI GROUP [1]

By W. V. KING
Of the International Health Division of the Rockefeller Foundation

FOUR PLATES AND SIX TEXT FIGURES

INTRODUCTION

Five species or subspecies belonging to this group (the *Pseudomyzomyia* group of the subgenus *Myzomyia* as defined by Christophers in 1924) are now known to occur in the Philippines. These consist of a local variety each of the species *Anopheles vagus* and *Anopheles subpictus* (*rossi*), two species that have previously been included under the name *ludlowi*, and *Anopheles parangensis*. The latter is known at present only from Min-

[1] The studies on which this paper is based were conducted with the support and under the auspices of the International Health Division of the Rockefeller Foundation, in coöperation with the Bureau of Science, the Philippine Health Service, and the United States Bureau of Entomology.

The author wishes to acknowledge his indebtedness especially to Dr. Victor G. Heiser, who arranged the present investigation of Philippine mosquitoes; to Mr. J. J. Mieldazis, whose familiarity with the territory and the breeding habits of the local *Anopheles* was of much assistance in the early part of the work; and to Mr. F. E. Baisas, who, under the writer's direct supervision, has reared and examined a large part of the mosquito material and who has made a majority of the camera-lucida drawings used as illustrations.

Some of the preliminary work on this and other groups was carried out during the first five months of 1929 and the study was resumed in November, 1930.

danao and the Celebes area but the others are generally prevalent in the Philippines and, with the possible exception of the fresh-water form of *A. ludlowi,* their near relatives are widely distributed in the Orient.

Although a great deal has been published on this group, the correct nomenclature of the Philippine species and their relationship to the forms occurring in other regions has not been satisfactorily settled. A special study of the local forms has therefore been made and comparative descriptions, with consideration of the taxonomic problems, are given in the present paper.[2]

The species described or discussed are shown in the following list:

Anopheles ludlowi Theobald (fresh-water *ludlowi*).
Anopheles litoralis sp. nov. (salt-water *ludlowi*).
Anopheles sundaicus Rodenwaldt (East Indian or Sunda Islands *ludlowi*).
Anopheles flavescens Swellengrebel.
Anopheles hatorii Koidzumi.
Anopheles parangensis Ludlow.
Anopheles subpictus var. *indefinitus* Ludlow.
Anopheles subpictus var. *malayensis* Hacker.

[2] Since this investigation was begun, a study of the group has been made by C. M. Urbino and a summary of his work has appeared in a bulletin of the Philippine Health Service. After the completion of the present article I find that his full manuscript has appeared in a local medical journal, Rev. Fil. Med. y Farm. 22 (1931) No. 5. It is unfortunate that the two studies were not better coördinated as a number of discrepancies have arisen, the most important of which is in the description of the leaflets of the mesosome of the male genitalia. The differences that I have given here and that have now been amply confirmed, were originally demonstrated to Mr. Urbino (for his personal information) following my preliminary work in 1929. From his published conclusions it is evident that some of his identifications, particularly of fresh-water *subpictus,* were at fault since the leaflets of the Philippine *subpictus* and *vagus* are not similar as stated by him. Other less important discrepancies have been noted as follows: (1) The average length given for the palmate hairs is greater than in my series, and it appears that the factor used in converting the ocular measurements to millimeters may have been incorrect. (2) The records of the occurrence of fringe spots between veins 5.2 and 6 are at variance, the only agreement being in fresh-water *ludlowi.* This spot also occurs in a fairly large proportion of my specimens of salt-water *ludlowi* (= *litoralis*) and I have not found it of value in distinguishing between the two species. (3) Several useful distinguishing characters in wing and leg markings are not included in the article.

Anopheles formosaensis II Tsuzuki.
Anopheles subpictus Grassi (type form).
Anopheles subpictus var. *indefinitus* from brackish water.
Anopheles vagus var. *limosus* var. nov.

At the beginning of the study in 1929, it was planned to collect and compare a large enough series of each of the commoner varieties to determine, if possible, the extent of normal variation, both in larval and adult characters. This was felt to be necessary on account of the close similarity between some of the forms and the confusion that has existed as to their relationship.

Larval breeding habits were also taken into account and, in order to become familiar with the distribution and preferred breeding places of the different species, nearly all of the collections were made in person, frequently accompanied by Mr. Mieldazis during the first four months of the work. When making the collections, the specimens from each breeding place were kept separated until identifications could be made so as to have exact records of their source and to determine the extent of association or lack of association of species.

Upon arrival at the laboratory, the fourth-stage larvæ were examined alive, counts of various hairs were recorded on a tabular form, and the specimens were then given an individual sub-number and isolated in small Petri dishes for rearing. Nearly all of the adults included in the study were from such identified and described larvæ. The cast larval skin from each individual was mounted and preserved under its proper number for reference purposes. Some of the characters are best observed in entire larvæ, but the cast skins have proven of value especially in checking the identification, in cases where some question arises later, and in looking up characters not originally noted.

The technic employed in the examination of the male genitalia differs somewhat from the usual methods. The leaflets of the mesosome (phallosome) have proven to be especially useful in the differentiation of certain members of this group, and in order to examine them under high magnification it is almost necessary to dissect off the mesosome, after the usual treatment of the genitalia with caustic soda, and to mount it under a separate cover glass. By this means the leaflets may be spread out and pressed down into one plane. If desired, the mesosome may also be split into two parts and the two halves separated in mounting so that the leaflets of one side do not overlie those

of the other. Care must be taken in the dissections that some of the leaflets are not broken off. Most of the specimens have been mounted in Gater's modification of Berlese's solution, which has a good index of refraction and with which the mesosome may be transferred directly from water.

The results of the present studies, combined with those of other workers, indicate with little question that the Philippine forms of this group are specifically distinct one from another. The recognition of Philippine varieties of the type forms of *vagus* and *subpictus* also appears warranted on the evidence available.

With reference to the use of a varietal as well as a specific name, the objection is sometimes made that the splitting of species does more to confuse than clarify the situation for the field worker. However, where the differences justify it, the practice is recognized as necessary for proper systematic treatment and, from the viewpoint of the field work, the use of varietal names is undoubtedly desirable in many cases if for no other reason than to indicate the affinities of the species and to call attention to the possibility of differences in habits. The lack of information on such differences, or the failure to recognize them, has resulted in considerable confusion as regards the connection of certain species with the transmission of malaria.

The group here dealt with is thought to be sufficiently well known so that the general characteristics may be omitted. The descriptive matter is therefore largely limited to comparative data. Tables have been added to show the occurrence of certain variable characters in the adults and larvæ and include some information not noted in the text.

Although some collecting of *Anopheles* has been done on islands other than Luzon, the comparative matter included here, with the exception of that pertaining to *Anopheles parangensis*, is restricted to Luzon material.

ANOPHELES LUDLOWI Theobald, 1903.

The two speckle-legged species that occur commonly on Luzon Island have been locally referred to in recent years under the names of salt-water and fresh-water *ludlowi*. Outside of the Philippines, it has not, I believe, been generally known that more than one species occur in the Islands and comparisons have been made sometimes with one and sometimes with the other of the two forms as representing typical *ludlowi*.

The original description of Theobald does not definitely show to which one of the two species the name should be applied and, according to Yamada (1925), the type specimen in the British Museum is now in poor condition. Nevertheless, the very definite statement by Miss Ludlow (1914) that the specimens on which the description was based were from an inland locality (Abra Province, Luzon), well removed from any salt-water source, would appear to settle the matter sufficiently clearly since, in numerous collections made by the members of the International Health Division and the Philippine Health Service, one of the forms has been found only in fresh-water breeding places associated with streams and the other only in salt-water ponds or pools near the coast.

Christophers (1924) called attention to the fact that the true *ludlowi* was not the species usually referred to as such but refrained from changing the name, in order to avoid confusion, and suggested that the fresh-water species be considered merely as *parangensis*. In the meantime, however, *parangensis* has been shown to be a distinct species and the East Indian form to differ from the type form. Since the latter, probably the most important member of the group, has now been renamed there is, of course, much less reason for arbitrarily retaining the name *ludlowi* to designate the salt-water species. Furthermore, it is probable that the strict application of the name would in any event be proposed sooner or later. After considerable thought, it has been decided to restrict the name to the fresh-water form in the present article and to propose a new name for the Philippine salt-water species.

The principal characters of *A. ludlowi*, based on a series of specimens from various fresh-water breeding places, are as follows:

Female.—Costal sector spot[3] of wings (Plate 1, fig. 1) invariably present in the material at hand; two white interruptions between this and the base of the wing; basal accessory dark spot without white scales on the anterior margin but a few white scales usually present over the bend near the extreme base of the wing; accessory sector spot on the subcostal vein present in about 40 per cent of the specimens, 44 per cent with three dark spots under the midcostal area, and 67 per cent with a dark patch of scales (sometimes only two or three) at the fork of vein 2; subapical dark costal spot forming from 29 to

[3] The terms used to designate the wing spots are shown in text fig. 1.

48 per cent of the area included in the costal measurement (see fig. 1), with an average of 37 per cent; vein 5.1 with an average of 35 per cent black to the total length of the branch; stem of vein 2 (measured from the supernumerary cross vein) about nine-tenths the length of the cell.

The fossa of the mesonotum (that is, the depressed lateral area in front of the suture) either bare of scales or with a few narrow ones similar to those on the dorsal surface—at most, one or two broad flat scales.

Legs, except for the white speckling, usually dark scaled ventrally as well as dorsally; white apical bands of mid tarsi usually slightly narrower than those on the hind feet; basal bands absent on the mid and hind feet or, if present, very indistinct.

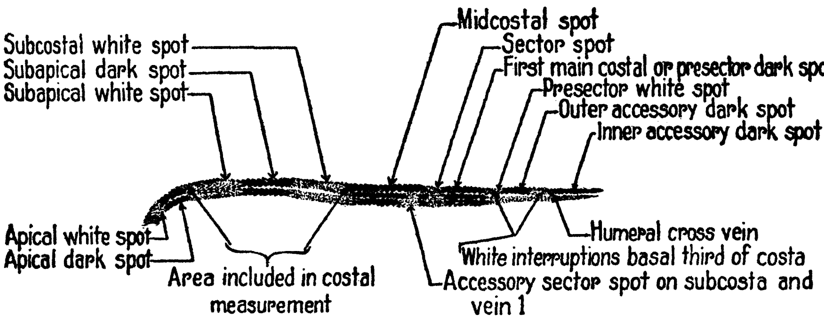


FIG. 1. Terms employed to designate the costal wing spots. Most of the names have been adapted from those used by S. R. Christophers and others.

Subapical black palpal band averages six-tenths the length of the apical white area; the latter frequently divided into two by an additional narrow band of black scales at the base of the apical segment.

Male genitalia.—Mesosome with three or four main leaflets (Plate 3, fig. 3, and Plate 4, fig. 3) on each side, the first one long, stout, widened near the base and S-shaped, with serrations on the outer edge of the lower curve; the next three or four leaflets also stout but progressively shorter, some of them also serrated. There are usually several short spikes at the base, or occasionally a longer slender leaflet. The long S-shaped leaflet averaged 53 μ in length in nine specimens, and the measurements for the next two in a typical group were 49 and 30 μ.

Larva.—Outer clypeal hairs more than half the length of inner; about three-fourths (77 per cent) of the outer occipital

hairs with four or more branches; anterior submedian thoracic hairs usually with more than nine branches each; thoracic palmate with an average of 3.6 hairlike branches; palmate of first abdominal segment with an average of 3.2 branches, not developed as leaflets (fig. 4, *c*); lateral hairs of abdominal segments IV to VI may or may not be irregularly branched but the first branches arise some distance from the base leaving a distinct "stalk" (fig. 5, *f*); the lateral hairs frequently 4-branched on

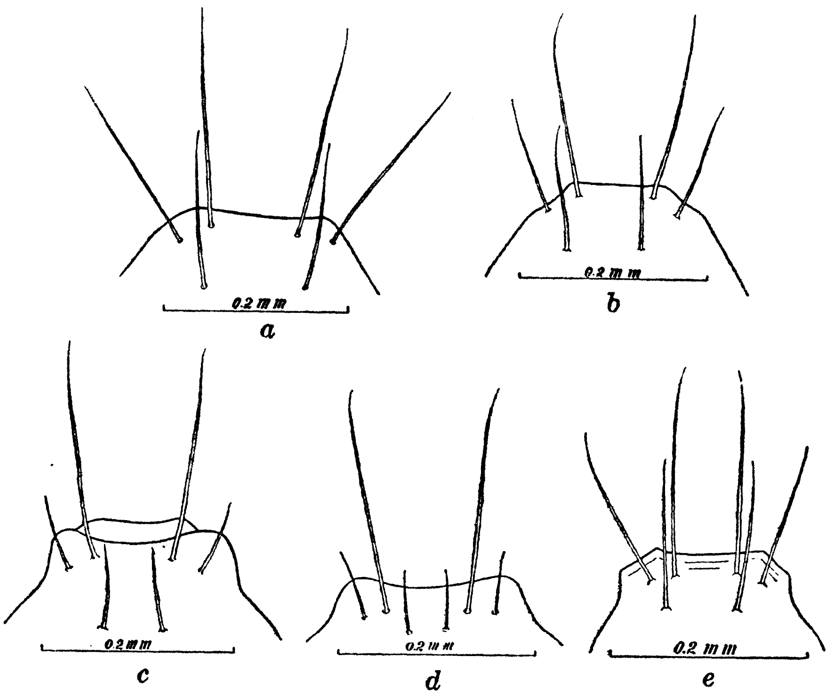


FIG. 2. Larval clypeal hairs; *a, Anopheles litoralis; b, Anopheles subpictus* var. *indefinitus* (also similar to *A. ludlowi*); *c, Anopheles vagus* var. *limosus; d, Anopheles vagus*, type form from Java; *e, Anopheles parangensis.*

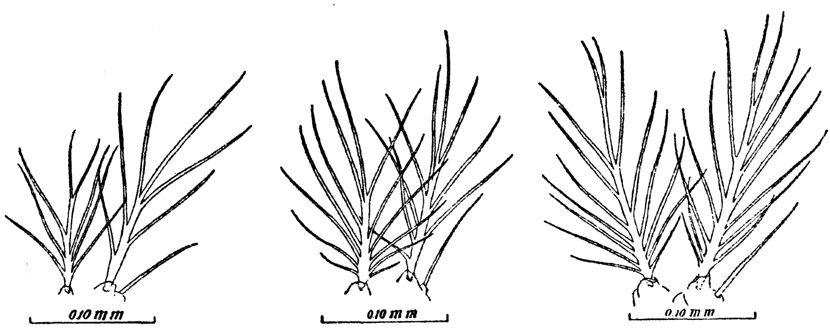
segment IV and 3- or 4-branched on segments V and VI; pecten with short and long teeth of nearly equal length (fig. 6, *c*).

ANOPHELES LITORALIS sp. nov. (Salt-water ludlowi.)

Female.—Costal sector spot of wing incomplete or absent in about 30 per cent of the specimens (see Table 3 and Plate 1, fig. 2); basal third of costa with two or three white interruptions; basal accessory dark spot almost invariably with some white scaling on the anterior margin, sometimes completely interrupting the black (counted as one of the basal white spots

in the latter case); accessory sector white spot of subcostal vein present in 70 per cent of the specimens examined; vein 1 under the midcostal area with two dark spots, the basal one sometimes with only one or two dark scales separating the sector from the accessory sector spots; stem of vein 2 without a patch of dark scales at the fork, the only exceptions among eighty-eight specimens being two with one or two dark scales at this point and six in which the usual dark spot on the center of the stem extended nearly to the fork; subapical costal dark spot forming about 38 per cent of the costal measurement, with variations from 26 to 50 per cent; vein 5.1 with an average of 44 per cent black to total length; stem of vein 2 averaging about nine-tenths (0.88) the length of the cell.

Fossa of mesonotum with scattered broad flat scales, usually about six to ten in number.



a b c

FIG. 3. Anterior submedian thoracic hairs; *a*, *Anopheles litoralis*; *b*, *Anopheles subpictus* var. *indefinitus* (also similar to *A. ludlowi* and *A. vagus* var. *limosus*; *c*, *Anopheles parangensis*.

Legs well speckled but the white spots usually not quite so contrasting or so numerous as in *ludlowi*; ventral surface of legs, especially the mid and hind femora and tibiæ and the fore tarsi, partly or almost completely yellowish scaled; segments 3 and 4 of the mid tarsi, frequently segment 2, with narrow though distinct basal white bands,[4] in addition to the apical bands of the preceding segment; segments 3 and 4 of hind legs often with very narrow basal bands also.

Palpal bands variable, the subapical black averaging slightly more than half (0.58) the length of the apical white; apical segment without an additional black band as observed in specimens of *ludlowi*.

[4] Noted by Yamada (1925) as differences between *A. hatorii* and what he took to be true *A. ludlowi* but were evidently the salt-water form.

Male genitalia.—Mesosome with from 8 to 14 leaflets on each side (Plate 3, fig. 1, and Plate 4, fig. 1), subequal in length except for short spikes at the base. In the ordinary mounts the leaflets are usually bunched so that the number and shape of the leaflets cannot be made out easily. When the mesosome is separated and mounted under a separate cover glass the longest leaflets and some of the others are found to be typically thin and flattened, with one side broadly rounded toward the tip and the other more or less straight and serrated. The longest leaflet,

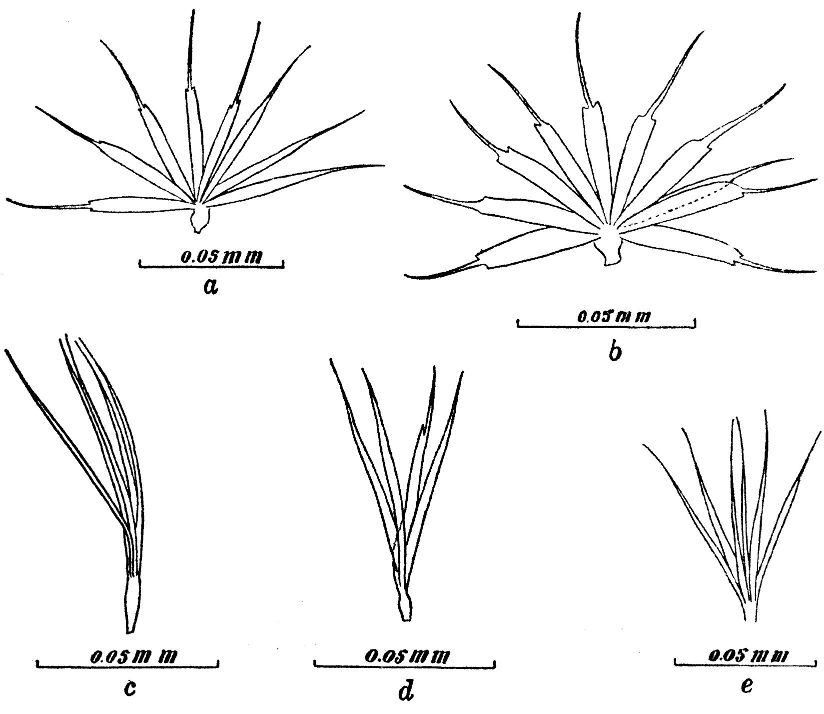


FIG. 4. Palmate hairs of first abdominal segment; *a, Anopheles subpictus* var. *indefinitus; b, Anopheles parangensis; c, Anopheles ludlowi; d, Anopheles vagus* var. *limosus; e, Anopheles litoralis.*

with an average length of about 42 μ, is much shorter than and differs in shape from that of either *ludlowi* or *vagus*. The leaflets are, however, similar to those of the Philippine *subpictus* except possibly for a slight difference in number and length.

Larva.—Clypeal hairs similar to those of *ludlowi* and *subpictus* except that the outer appear to be slightly longer (fig. 2, *a*); all clypeal hairs usually simple but occasionally forked or double;

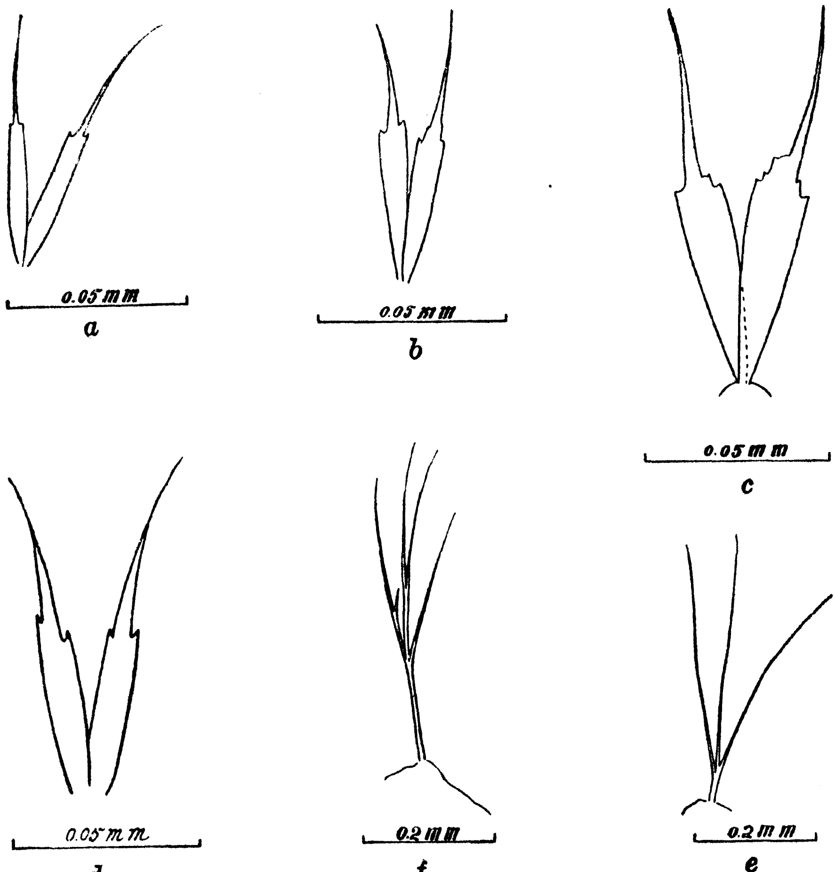


FIG. 5. Leaflets of palmate hairs from abdominal segment IV (*a* to *d*) and lateral hairs from same segment (*e* and *f*); *a*, *Anopheles litoralis*; *b*, *Anopheles vagus* var. *limosus*; *c*, *Anopheles parangensis*; *d*, *Anopheles subpictus* var. *indefinitus*; *e*, *Anopheles litoralis*, lateral hair; *f*, *Anopheles ludlowi*.

outer occipital hairs very seldom with more than three branches; anterior thoracic hairs (fig. 3, *a*) usually less than 9-branched;[5] thoracic palmate with three or two (average 2.3) hairlike branches; palmate I also undeveloped, with an average of 5.3 hairlike branches (fig. 4, *e*); leaflets of other palmates smaller

[5] Table 6 shows 91 per cent of the hairs with less than nine branches. However, in another series of larvæ recently examined (1931) only 62 per cent had less than nine and the average number was eight instead of less than seven in the previous series. There were four out of forty-seven larvæ in the second series in which all four hairs had more than eight branches.

than in subpictus (fig. 5, *a*); lateral hair of segments IV to VI usually 3-branched, the branches arising near the base, without an elongated stem as in *ludlowi* (fig. 5, *e*); antepalmate of segment VI 2- or 3-branched in about half (47 per cent) of the specimens; pecten with long and short teeth of nearly the same length (fig. 6, *a*).

Type female.—Reared from larva collected in a salt-water fishpond near Parañaque, Rizal, Luzon, December 24, 1930.

The form of branching of the lateral hairs is usually reliable for separating the larvæ of *ludlowi* and *litoralis*, while the num-

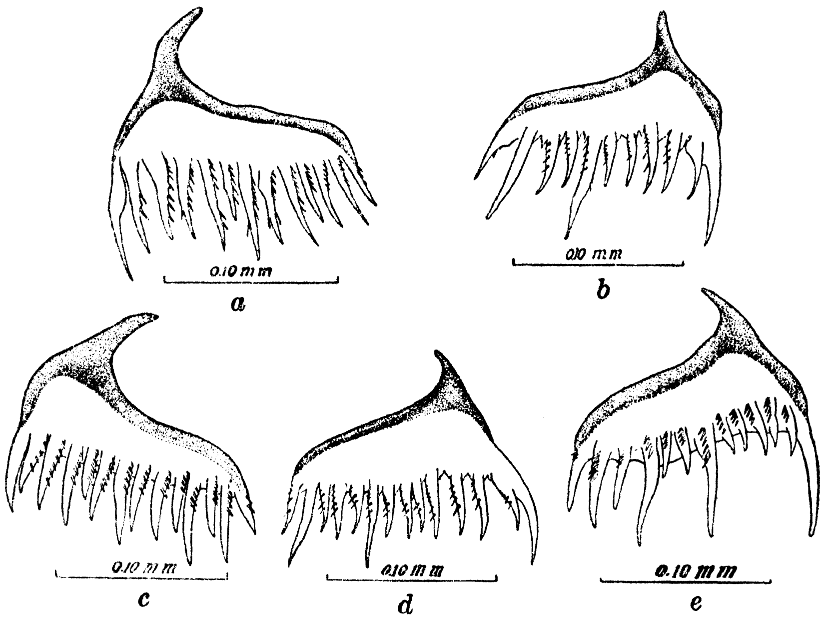


FIG. 6. Pectens of eighth abdominal segment; *a*, *Anopheles litoralis*; *b*, *Anopheles subpictus* var. *indefinitus*; *c*, *Anopheles ludlowi*; *d*, *Anopheles vagus* var. *limosus*; *e*, *Anopheles parangensis*.

ber of branches in the anterior thoracic hairs, the outer occipital hairs, the undeveloped thoracic palmate and palmate I, and the antepalmate hairs of segment VI may be useful for confirmation, especially in a series. The only species with which *litoralis* larvæ have been taken is the brackish-water breeding *subpictus*. The most useful characters for separating these two are the shape of the pectens and of the palmate hairs on segment I.

The first description of this form, under the name of *ludlowi*, appears to be that of Banks (1907) who described the male and

larva and gave an account of the life history. Although the characters given are not sufficient to recognize the species with certainty he states that the material was from salt-water sources.

Yamada appears to be the first to indicate specific differences in the markings of the two forms. (See remarks under *A. hatorii.*)

The breeding places of *litoralis* are discussed below in connection with those of *sundaicus.*

COMPARISON OF ANOPHELES LITORALIS AND LUDLOWI WITH ANOPHELES SUNDAICUS RODENWALDT, 1925

Although *litoralis* and *ludlowi* are almost certainly specifically distinct, their relation to the variety occurring in brackish-water fishponds in the Netherlands East Indies is not so clear. The East Indian form (described as *Myzomyia ludlowi* var. *sundaica*) was separated from the type species on the basis of the relative widths of certain spots on the female wing. The author gives the distribution of this variety as "The Major and Minor Sunda Islands from Roma to Sumatra, the peninsula of Malacca and surrounding islands and on the Andamans."

The specimens from the Philippines which he had for comparison were probably the true *ludlowi.* They were sent to him by Mr. Tiedeman, most of whose material was, I believe, obtained from fresh-water rivers in Pampanga Province, Luzon. The distinguishing wing characters, or at least the measurements, given by Rodenwaldt would apply almost equally well to either of the Philippine forms. In Table 1 are given comparative measurements for certain characters in *ludlowi, litoralis,* and a few specimens of what are presumably *sundaicus* from Singapore, obtained through the kindness of Dr. C. H. Yeager. It may be noted that the measurements of the costa and vein 5.1 agree fairly well with those given by Rodenwaldt. His averages for *sundaicus* (all specimens) were 56 per cent black in the costal measurement and 63.6 per cent black on vein 5.1, as compared with my averages of 57 and 58 per cent for the Singapore material; his averages for the Philippine *ludlowi* were 35 per cent and 31 per cent, respectively, as compared with my averages of 37 and 35 per cent for *ludlowi* and 38 and 44 per cent for *litoralis.* (Compare figs. 1, 2, and 3 of Plate 1 for the wings of the three species.)

An accessory sector white spot on the subcostal vein was found by Rodenwaldt only once in 150 specimens, while in my

TABLE 1.—*Measurements of female palpal bands, wing spots, and vein 2.*[a] (*Speckle-legged species of Anopheles of the Pseudomyzomyia group.*)

	Anopheles litoralis (Luzon).	*Anopheles ludlowi* (Luzon).	*Anopheles sundaicus* (Singapore).	*Anopheles parangensis* (Mindanao).
Palpal apical bands:				
Number of measurements	46	25	12	11
Length of white plus dark.....mm	0.43	0.34	0.45	0.37
Ratio of black to white	0.58	[b] 0.60	0.69	0.73
Variation in ratio	0.39–0.94	0.29–1.00	0.37–1.00	0.54–0.86
Costal spots (see text fig. 1):				
Number of measurements	46	25	22	11
Per cent of black	38	37	57	26
Variation in per cent of black	26–50	29–48	47–65	21–32
Vein 5.1:				
Number of measurements	44	24	17	------------
Per cent of black	44	35	58	------------
Variation in per cent of black	35–60	30–49	43–85	------------
Vein 2:				
Number of measurements	25	25	23	9
Length of cell (average).....mm	0.68	0.66	0.82	0.75
Length of stem (to crossvein) .mm	0.60	0.60	0.49	0.58
Ratio of stem to cell	0.88	0.90	0.58	0.77
Variation in ratio	0.76–1.05	0.74–1.00	0.54–0.68	0.73–0.82

[a] Measurements were made from one wing per specimen except in *sundaicus* and *parangensis*, in which both wings were measured in most of the specimens. The measurements were made with an ocular micrometer at magnifications of 57 and 24.

[b] Does not include the additional black band which occurs in some specimens of *ludlowi* at the base of the apical joint.

TABLE 2.—*Measurements of palpal bands, wing spots, and vein 2.* (*Non-speckle-legged species of Anopheles of the Pseudomyzomyia group.*)

	Anopheles subpictus var. *indefinitus*.		*Anopheles subpictus* (India).	*Anopheles vagus* var. *limosus*.
	Brackish water.	Fresh water.		
Palpal apical bands:				
Number of measurements	20	47	22	36
Average length.....mm	0.36	0.34	0.45	0.33
Ratio of black to white	0.51	0.52	0.97	0.37
Variation in ratio	0.31–0.91	0.23–0.77	0.57–1.67	0.20–0.58
Costal spots:				
Number of measurements	20	20	21	20
Subapical white (length).....mm	0.24	0.22	0.31	0.35
Subapical black.....mm	0.42	0.40	0.35	0.28
Subcostal white.....mm	0.19	0.19	0.38	0.40
Total length (average).....mm	0.85	0.81	1.04	1.03
Per cent of black	49	48	34	27
Variation in per cent of black	37–65	38–57	24–42	16–37
Vein 5.1:				
Number of measurements	20	20	------------	19
Per cent of black	53	51	------------	44
Variation in per cent of black	44–61	39–75	------------	33–59

series it occurs in 74 out of 106 *litoralis* and in 17 out of 43 *ludlowi* (see Table 3). He states that three dark spots sometimes occur on vein 2.2, which has not been noted in the Philippine material. He also states that fringe spots between the veins are absent in *sundaicus* and this is true of all the Singapore specimens, while a light spot between veins 5.2 and 6

TABLE 3.—*Variation in occurrence of spots on female wing.*[a] *(Speckle-legged species of Anopheles of the Pseudomyzomyia group.)*

	Anopheles litoralis.		*Anopheles ludlowi.*		*Anopheles sundaicus.*		*Anopheles parangensis.*	
	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
Specimens examined[b]	88–106	------	43–45	------	10–12	------	7	------
White spots, basal third of costa:								
One	0	------	0	------	2	------	0	------
Two	81	------	45	------	9	------	7	------
Three	17	17	0	0	0	0	0	0
Sector spot on costa:								
Present	68	------	45	------	9	------	7	------
Incomplete[c]	6	6	0	0	3	25	0	0
Absent	23	24	0	0	0	0	0	0
Accessory sector spot on subcosta:								
Present	74	70	17	40	0	0	7	100
Absent	32	------	26	------	12	------	0	------
Accessory sector and sector spots on vein 1:								
Continuous	0	0	2	5	0	0	0	0
Slight black between[d]	27	------	7	------	2	------	3	------
Separated	79	------	34	------	10	------	4	------
Number dark spots on vein 1 under midcostal spot:								
One	0	------	2	------	0	------	0	------
Two	106	------	23	------	12	------	7	------
Three	0	0	20	44	0	0	0	0
Black spot at fork of vein 2:								
Absent	80	91	14	33	9	75	7	100
One to 3 dark scales	2	------	11	------	2	------	0	------
Patch of scales	[e] 6	------	18	------	1	------	0	------
Fringe spot between veins 5.2 and 6:								
Present	34	35	30	68	0	0	7	100
Absent	63	------	14	------	10	------	0	------

[a] Variations sometimes occur in the markings of the wings of the same specimens. The characters were recorded from one wing on the same side (left) unless this one was in poor condition for examination.

[b] Some specimens were rubbed and for this and other reasons the characters were not recorded from the same number of specimens in all cases.

[c] With dark scales on anterior side and white scales on posterior side of costal vein.

[d] One to three dark scales; counted as a dark spot in next tabulation.

[e] Central spot on stem extended to fork; not a separate patch of scales.

occurs in about one-third (35 per cent) of the Philippine *litoralis* and two-thirds (68 per cent) of the *ludlowi*.

In the Singapore specimens the basal black spot of the costa is without white scaling on the anterior margin as in *ludlowi* and the ventral scaling of the legs is also more like *ludlowi* than *litoralis*.

TABLE 4.—*Variation in occurrence of spots on female wing. (Non-speckle-legged species.)*

	Anopheles subpictus var. *indefinitus*.				*Anopheles subpictus* (India).		*Anopheles vagus* var. *limosus*.	
	Brackish water.		Fresh water.					
	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
Specimens examined	82–95	------	52–60	------	22	------	50–53	------
White spots, basal third of costa:								
One spot	13	14	4	7	0	0	0	0
Two spots	82	------	56	------	[a] 8	------	50	------
Three spots	0	0	0	0	14	64	0	0
Prehumeral white spot present	0	------	[b] 0	------	21	95	0	------
Sector spot on costa:								
Present	88	------	53	------	21	------	49	------
Incomplete	1	4	4	12	1	5	1	2
Absent	3		3		------	------	------	------
Accessory sector on subcosta:								
Present	37	40	21	38	1	5	7	14
Absent	55	------	35	------	21	------	43	------
Accessory sector and sector spots on vein 1:								
Continuous [c]	20	21	9	16	12	55	7	11
Slight black between	19	------	15	------	10	------	9	------
Separated	56	------	34	------	0	------	37	------
Presector dark spot on vein 1:								
Absent	0	------	0	------	4	55	7	68
Shortened	8	9	3	6	8		29	
Long [d]	78	------	50	------	10	------	17	------
Fringe spot between veins 5.2 and 6:								
Present	12	13	13	25	19	90	27	54
Absent	80	------	39	------	2	------	23	------

[a] Prehumeral white spot absent in only one of these and the presector white spot absent in one. The others had one long spot, due to the absence of either the inner or outer accessory dark spots.

[b] Part of the *indefinitus* have white scales on the anterior edge of the costa near the base but not a complete white spot involving both sides of the vein.

[c] This is also the number with one dark spot on vein 1 under the midcostal spot except in one specimen of fresh-water *indefinitus* that had no dark spot.

[d] More than half the length of presector spot on costa.

A further important difference is found in the relative length of the forks and stem of vein 2. The ratio of the stem (measured from the supernumerary cross vein) to the posterior branch is 0.88 for *ludlowi,* 0.90 for *litoralis,* but only 0.58 for the Singapore *sundaicus* (see Table 1). Most of the illustrations of the wings of *sundaicus* given by Rodenwaldt also show the comparatively short stem.

The leaflets of the mesosome of the Singapore *sundaicus* are similar to those of *litoralis* and the Philippine *subpictus* so far as observed in the specimens examined, except for very slight differences in length of the longest leaflet, *sundaicus* being intermediate between these two species (Table 5).

The larvæ of the East Indian *ludlowi* and *subpictus* are said to be very similar except in the shape of the pecten, which Walch and Soesilo (1929) have recently used as a distinguishing character. Quite curiously their *ludlowi* type of pecten resembles the pectens of our *subpictus* (with short and long teeth of distinctly different length). If the character holds good it is also a distinction between *sundaicus* and *litoralis-ludlowi.*

In two mounted larval specimens from Singapore (loaned me by Doctor Yeager) both inner occipital hairs are bifid in each specimen (instead of the usual simple hair); the number of branches of the inner anterior thoracic hairs are 8–9 and 11–12 and in the middle hairs 11–10 and 13–14 (an average of 11 branches each); the antepalmate hairs on segment VI are all simple. The pecten of one of these specimens is similar to our material and not as given by Walch and Soesilo. Unfortunately, a sufficient number of authentic *sundaicus* larvæ are not available for a detailed comparison.

On biological grounds the differences between *sundaicus* and *litoralis* appear to be quite marked in certain characteristics. Along the coast of the bay on both sides of Manila are considerable areas of salt-water fishponds with a very large output of *Anopheles litoralis;* but, so far as I am informed, no serious trouble from malaria has ever been experienced in the vicinity of these breeding places. On the other hand, the East Indian *ludlowi* (= *sundaicus*), as is well known, is considered to be the principal carrier of malaria in Java and other of the Sunda Islands.

The salt content of the water most favorable for breeding evidently differs also. The Philippine form is found in abundance in water having a salt content of sea water or higher and

may or may not occur in brackish-water pools nearby. We have found it entirely replaced by *subpictus* in slightly brackish pools. The fishponds examined during the dry season have shown a specific-gravity reading equivalent to from 3.1 to 3.6 per cent salt or about equal to that of sea water. Larvæ of *litoralis* have also been taken in large numbers in partially concentrated pools connected with salt evaporation beds and containing from 4.2 to 7.4 per cent salt.[6] In the highest concentration full-grown larvæ and pupæ were collected in algal mats and adults emerged normally from these specimens.

In comparison with these records, the East Indian form is reported to thrive best at a salt percentage from 1.2 to 1.8 and to disappear when the salt content goes above 3 per cent (Rodenwaldt and Essed, 1925, and van Breemen, 1930). The Java salt-water *subpictus* is said to breed at higher salt percentages and this is just the reverse of the habits of the Philippine forms since our salt-water *subpictus* is limited to brackish water.

In regard to the nomenclature of these species, the least confusing solution would probably be to designate both *litoralis* and *sundaicus* as varieties of *ludlowi,* as Rodenwaldt has done with *sundaicus.* This would not be consistent, however, in view of the fact that the genitalia of *ludlowi* (a character that Rodenwaldt did not consider) are distinct and the differences in the female and larva are at least of the same order as those separating *subpictus* and *vagus.*

The similarity in the leaflets of the mesosome of *litoralis* and *sundaicus* would indicate a closer relationship between these two but is not necessarily final since the case of the Philippine *subpictus* shows that even in this group the leaflets may be quite similar in distinct species and such similarity is known of course in other groups. On the other hand, the difference between the two forms in the relative length of the first forked cell and its stem is very possibly specific. For this reason it has not seemed desirable to designate *litoralis* as a variety of *sundaicus* until a

[6] The salt concentration was estimated in most cases from specific-gravity readings. The highest percentage determination (7.4) was checked with a standard specific-gravity spindle and several of the others were checked by chlorine titrations made for me by Mr. R. H. Aguilar, of the Bureau of Science. The percentages obtained by the two methods were very close, provided the specific-gravity readings were properly adjusted for the temperature at which the spindles were calibrated.

further comparative study of the latter can be made. Moreover, a slight question still exists as to the correct name of the Malasian form. Christophers (1924) made *Anopheles flavescens* Swellengrebel (1921) a synonym of *ludlowi* as he thought it probably only a flavescent form and not a true local variety. The species was described from a specimen or specimens taken at Soerabaja, Java, and so far as I can ascertain has not again been encountered. It was said to be intermediate between *ludlowi* (= *sundaicus*) and *immaculatus* and the only *ludlowi*-like character mentioned was the amount of black scaling on vein 5.1 (three-fourths dark below the cross vein). All dark scaling was said to be bleached and the legs entirely pale. Since the legs were not speckled perhaps it could be considered a synonym of *subpictus* and thus avoid the necessity of substituting the name for *sundaicus*.

Reference should also be made to *Anopheles hatorii* Koidzumi, the Formosan form, which Yamada (1925) considered to be distinct from *ludlowi* after comparison with material in the British Museum. It appears from his description, however, that the specimens examined there were probably the salt-water form and not the true *ludlowi*. He states that the type specimen was in poor condition and that the comparison was made with specimens subsequently sent to the museum and bearing the identification labels of Banks and Ludlow.

For *A. hatorii*, he describes three dark spots on vein 1 under the midcostal area, a spot of dark scales at the fork of vein 2 and the mid and hind tarsi without basal banding, which indicate *ludlowi*. The leaflets of the mesosome of a male specimen obtained from the United States National Museum and labeled "*A. hatorii*, E. Formosa, V–1918" are, I find, similar to those of *ludlowi*. The long leaflet on each side is stout and S-shaped with a length of 56 μ.

While the two forms might be geographical varieties, Yamada's detailed description does not show distinct differences on which to separate them.

ANOPHELES PARANGENSIS Ludlow, 1914.

This species was described from very much speckled specimens sent from Parang, Mindanao, one of the southern islands. Miss Ludlow stated that it had not been received from any other locality and her mosquito collection, now in the United States National Museum at Washington, contains only two type specimens.

On a recent collecting trip to Mindanao (March and April, 1931), *parangensis* larvæ were taken in a fresh-water pool near the coast in Oriental Misamis Province, and a few adult specimens were reared from these. The larvæ were associated with *A. pseudobarbirostris* and *A. subpictus* var. *indefinitus* although the latter were somewhat differently distributed in the pool.

Rodenwaldt (1925 and 1926) has given a good description of the male, female, and larva from Celebes specimens. The description agrees very well with the Mindanao material with the possible exception of certain characters of the male genitalia, particularly the bulbous membrane with modified leaflets on the mesosome and the outer blunt spines on the harpagones noted in the Mindanao specimens. These were not mentioned by Rodenwaldt but may have been merely overlooked.

The principal characteristics of the species, based on the Mindanao material, are summarized below:

Female.—Sixth vein of wing (Plate 2, fig. 4) with three dark spots;[7] a wide fringe spot between veins 5.1 and 5.2 (in addition to the usual fringe spots at the tips of the longitudinal veins and between veins 5.2 and 6); subapical costal dark spot very short, averaging about one-fourth of the distal costal area and similar in this respect to the Philippine *vagus;* a prominent accessory sector spot on the subcosta in all specimens; two dark spots on vein 1 under midcostal spot, the end of the outer one even or nearly even with the distal end of the mid-costal spot; two white interruptions on basal third of costa and extreme base of costa usually white for a short distance.

Legs much speckled, the light scales forming distinct intermediate bands on the first three tarsal segments of the hind legs and usually one band in the middle of the 4th segment; tarsal segments of front legs broadly banded apically and basally; segments 1 to 4 of mid and hind tarsi with narrow apical bands and mid tarsal segments with a few basal white scales ventrally.

Palpi with the subapical dark band about three-fourths (0.73) the length of the apical white.

Male genitalia.—(Plate 3, fig. 5.) As noted by Rodenwaldt, who has described and figured the genitalia, these differ remarkably from the other species in the subgenus *Myzomyia.* The usual group of parabasal spines is absent and two unmodified

[7] The basal spot was said by Rodenwaldt to be lacking sometimes. Three dark spots on vein 6 occur very rarely in *A. ludlowi.*

hairs, one very long and one very short, occur in this area. On the inner face of the side piece near the basal ring is an expanded or spoon-shaped blade arising from a tubercle. Another short hair occurs near the base of the tubercle. In a freshly dissected specimen, examined before mounting, the spoon-shaped blade appears to be semimembranous toward the apex and the base is in the shape of a trough (Plate 3, fig. 5, *b*). It has hardly any resemblance to the stout spines found in the subgenus *Anopheles.* The principal lobe of the harpago (fig. 5, *c*) is extended into a fingerlike process bearing a flattened blade, split at the tip. A smaller outer lobe bears a short hair and a longer, stout, blunt spine, the latter double on each side in one of three specimens. The usual leaflets are lacking on the mesosome and in place of these a peculiar transparent bulbous membrane (not mentioned by Rodenwaldt) surrounds the end dorsally; that is, on the side toward the anal segment. Along each side of the membrane are a number of short, overlapping, modified leaflets, apparently fused basally. In fig. 5, *c,* Plate 3, the leaflets are shown in a single row, although after mounting and under higher magnification there appears to be a double layer of leaflets on each side.

Larva.—Clypeal hairs long and slender, usually simple (fig. 2, *e*); two specimens out of twenty-two with one of the inner hairs forked, one with an outer and one with a posterior hair forked;[8] anterior thoracic hairs more heavily branched than in *subpictus* or *ludlowi* with an average of fifteen or sixteen branches (fig. 3, *c*); thoracic palmate with an average of five hairlike branches; first abdominal palmate tuft typically developed, although small (fig. 4, *b*); those on the other segments unusually broad and often pigmented (fig. 5, *c*); tergal plates similar to *subpictus* (var. *indefinitus*), or slightly broader. Pecten (fig. 6, *e*) with about nine short and four long teeth, the short teeth at the lower end hardly more than one-third the length of the long teeth.

The long hairs in the pleural hair[9] group of the prothorax consist of two simple hairs and one feathered hair; the group on the mesothorax with one long simple hair and one sparsely

[8] The clypeal hairs of the Celebes specimens, especially the outer, appear to have more of a tendency toward branching. According to Rodenwaldt they are often bifurcated or may have from two to three side branches.

[9] The term used by Puri (1928) to designate the paired ventrolateral groups of hairs of the thorax, one pair on each of the three segments.

feathered; the mesothorax with two long feathered hairs. Basal tubercle on the pro- and mesothorax with a large sharp spine; a shorter one on the metathorax. Other larval characters are shown in table 6.

The larva of *parangensis* is closest to the Philippine form of *subpictus* in the characters generally employed for identification, but the two can usually be separated readily enough by the shape of the first palmate hairs and the anterior thoracic hairs, as stated by Rodenwaldt. A few specimens, however, were found to be intermediate and in these cases positive identifications could be made by the presence of feathered hairs in the pleural hair groups of the pro- and mesothorax. In *subpictus* (as well as *vagus* and *ludlowi*) one of the long hairs in each group may be 2- or 3-branched toward the tip, but none of the hairs in either group is feathered.

The differences in the larval and genitalic characters raise the question as to the affinities of this species. On the basis of the pleural hairs it would fall into Group II of Puri's classification, with *maculatus*, *philippinensis*, etc. (group *Neocellia* of Christophers), instead of Group III containing *subpictus*, *vagus*, and *ludlowi* (group *Pseudomyzomyia* of Christophers). The adults of *parangensis*, however, have narrow scales on the mesonotum and two or three large prosternal hairs, as in *Pseudomyzomyia*. Most of the other adult and larval characters are also typical of the group, and I think it probably correct to assume that it comes nearest to *Pseudomyzomyia*, in spite of the pleural hairs and the freakish male hypopygium.

ANOPHELES SUBPICTUS var. INDEFINITUS Ludlow 1904. (Anopheles indefinitus.)

It is somewhat unfortunate that the name *indefinitus* should have to be resurrected since it has been used in the literature to designate both *subpictus* and *vagus*. Nevertheless, a recent examination of the type material in the United States National Museum leaves little doubt that at least two of the four specimens bearing the type label are of the *subpictus* form; the other two are too badly damaged to be identified. In the two better specimens the palpal subapical black bands are from 0.6 to 0.8 as long as the apical white, while the subapical black costal spots of the wings are wider than the white spots on either side. Measurements of the two specimens made for me by Mr. C. T. Green gave 50 per cent and 47 per cent as the proportion of black in the total length of the three costal spots. These percentages fall outside the range of variability for *vagus* variety

(Table 2) but are very close to the average for the Philippine *subpictus* specimens. This confirms the synonymy previously given by Christophers (1916 and 1924).

Through the kindness of Maj. G. Covell who has sent me a good series of *subpictus* from Larkana, India, I have been able to compare the Philippine form with the type form. As noted in connection with the descriptions below, the differences in the palpal, wing, and especially the genitalic characters are of about the same order as those distinguishing the Philippine *subpictus* and *vagus*. While I believe that *indefinitus* is a distinct species and should be so treated, I have retained it as a variety for the present in order to avoid the confusion resulting from the previous misapplication of the name.

Female (*var. indefinitus from fresh water*).—Palpal bands variable (see Table 2), the subapical dark averages about one-half (0.52) the length of the apical white; subapical dark spot on costa of wing (Plate 2, fig. 2) as wide as and usually distinctly wider than the white spot on either side; subcostal white spot usually shorter than subapical white; dark presector spot on vein 1 usually more than half as wide as the costal spot above it; two, sometimes one, white interruptions on the basal third of the costa, formed by the humeral white spot which is invariably present and the presector white spot which is usually present; scattered white scales frequently occur along the anterior edge of the base of the costa but no specimens noted with a complete prehumeral white spot similar to that in the type form; fringe spot between veins 5.2 and 6 present in 25 per cent of the specimens. Hind tarsal segments with apical but not basal white banding; mid tarsi with narrow apical bands on segments 1 to 3 and usually with a few basal pale scales ventrally on segments 2 to 4.

Fore tarsi of male with a narrow though usually fairly distinct basal and apical band at tarsal joint 3–4.

Male genitalia.—Mesosome with from 6 to 13 leaflets on each side (Plate 3, fig. 2, and Plate 4, fig. 2), much shorter than in *vagus* [10] and with less difference in length between the indi-

[10] Not similar to those of *vagus* as stated by C. M. Urbino (see footnote 2). He also states that fresh-water *subpictus* as well as salt-water *ludlowi* and *vagus* have non-serrated leaflets and differ from salt-water *subpictus* in this respect. However, when properly mounted, serrated leaflets are to be seen in all of these forms.

vidual leaflets, as in *litoralis;* most of the leaflets flattened and bladelike, and with serrations on the straight side.

Larva.—Clypeal hairs (fig. 2, *b*) usually simple but occasionally forked (as occurs in nearly all species of this group), the outer and posterior hairs from one-half to three-fourths the length of the inner and the posterior extend about half their length beyond the base of the inner; thoracic palmate undeveloped; palmate of abdominal segment I (fig. 4, *a*) with an average of 7.6 leaflets, partly developed, the leaflets spread, somewhat broadened, and with a terminal filament; leaflets of other palmate tufts (fig. 5, *d*) usually wider and longer than in the Philippine *vagus* (noted by C. M. Urbino); ratio of filament to branch (leaflets of palmate IV) about 0.85, total length about 0.1 millimeter; lateral hairs of abdominal segment IV usually 3-branched, seldom two as in *vagus;* pecten (fig. 6, *b*) with four or five long teeth and eight or so short teeth, the latter about one-half the length of the former, especially on the lower end.

The Philippine species has sometimes been identified as *Anopheles subpictus* var. *malayensis* Hacker, 1921, a variety originally separated from the type form on the basis of a greater variability in the palpal banding. The two may be distinct but in any event the name *indefinitus* antedates this and should be applied to the local species.

I have recently had an opportunity to examine fourteen larvæ of var. *malayensis* from the Federated Malay States, for which I am indebted to Dr. A. N. Kingsbury and Mr. E. P. Hodge, of the Institute for Medical Research, Kuala Lumpur. Certain slight differences in comparison with *indefinitus* were observed, as follows:

Anterior submedian thoracic hairs somewhat more branched, the inner with an average of 17.5 branches compared with 13.2 in *indefinitus* and the middle hairs with an average of 15.8 compared with 12.2. The range for the inner was from 11 to 21 and for the middle hair, from 11 to 20. Palmate I more typically developed than in *indefinitus* and similar to *parangensis* in this respect; average number of leaflets 10.5 (range 8 to 13) compared with the average of 7.6 in *indefinitus*. The leaflets of palmate IV appear to be somewhat larger, with a total length of filament and blade of about 0.12 millimeter and the filament approximately equal to the blade in length.

Other larval characters are similar to those of *indefinitus* as given in Table 6 and the pecten has long and short teeth of distinctly different lengths.

The leaflets of the male mesosome, in two specimens, are more nearly similar to *indefinitus* than to the type form; the apical leaflet slightly longer (42 μ long) and narrower than in *indefinitus*.

Yamada (1925) considered both *indefinitus* and *vagus* to be synonymous with *Anopheles formosaensis II* Tsuzuki, 1902. The name *formosaensis*, however, is preoccupied and the combination "*formosaensis* II" appears to be invalid. Judging from some of the characters given by Yamada for the Formosan specimens it is probable that they were of the *indefinitus* type (as defined here), rather than *vagus*.[11] The characters that indicate *indefinitus* are: Subapical dark band on the female palpi from one-half to two-thirds the width of the apical white, subcostal white spot of the wing slightly shorter than the subapical dark spot, presector dark spot on vein 1 three-fifths the length of the costal spot above it and the basal dark spot on the costa (inner accessory dark spot) with white scales on the anterior margin. The banding of the hind tarsi may also indicate *indefinitus*, in which basal white bands are absent as noted by Yamada for *formosaensis II*. Their occurrence on *vagus*, however, is very irregular.

ANOPHELES SUBPICTUS Grassi, 1899. (Type form.)

The series of specimens from Larkana, Sind, India, furnished by Major Covell, show a number of differences from the Philippine material as follows: Palpal black bands wider, about equal in width to the apical white; subapical black costal spot of wing (Plate 2, fig. 3) shorter, usually less than the length of the white on either side; basal third of costa mostly white scaled, usually divided into three white areas consisting of presector, humeral, and prehumeral white spots, the latter sometimes continuous with the humeral spot. The prehumeral white spot is absent in only one of twenty-two specimens and the presector white spot absent in one. A fringe spot between veins 5.2 and 6 is present in all except two specimens and is sometimes continuous with the fringe spot opposite 5.2.

[11] Dönitz (1903, p. 234) thought that a specimen of *formosaensis II*, received from Tsuzuki, also had a greater likeness to *A. rossi* than to *A. vagus*.

TABLE 5.—*Measurements of the longest leaflet of the mesosome in several species of Anopheles.*[a]

Species.	Locality.	Number measured.	Average length (microns) and standard deviation.	Variation (microns).
Anopheles litoralis	Philippine Islands	19	42 ± 1.0	31–47
Anopheles ludlowi	do	9	53 ± 1.7	47–64
Anopheles sundaicus	Singapore	5	39	37–42
Anopheles subpictus	India	7	57	51–59
Anopheles subpictus var. *indefinitus*:				
Brackish water	Philippine Islands	18	36 ± 0.6	31–40
Fresh water	do	21	36 ± 0.7	28–40
Anopheles vagus	Java	3	72	71–75
Anopheles vagus var. *limosus*	Philippine Islands	15	68 ± 1.0	61–75

[a] Measured with an ocular micrometer at a magnification of × 425.

Male genitalia.—The leaflets of the mesosome (Plate 4, fig. 5) are somewhat intermediate between *vagus* and *indefinitus* but nearer to those of *vagus*. The first leaflet is long, stout, and tapered, with an average length of 57 μ compared with 68 μ in the Philippine *vagus* and 36 μ in *indefinitus*. As shown by the illustration, it differs slightly in shape from that of *vagus* and quite decidedly from that of *indefinitus*. There may also be more short leaflets than in *vagus*. As in all the other members of the group some of the leaflets are serrated, the long one on the basal half. Although the two Philippine species are readily identified by the shape and length of the leaflets, I should expect more difficulty in distinguishing *vagus* from the type form of *subpictus*, except possibly by actual measurement.

ANOPHELES SUBPICTUS FROM BRACKISH WATER

In two places near Manila are certain brackish-water ponds in which *subpictus* type of larvæ giving rise to adults with unspotted legs can usually be found. The water in these ponds appears to be seep water or overflow water from nearby fishponds and salt beds, diluted by rain water, and there is considerable fluctuation in the salt content. Occasionally, a mixture of *subpictus* and *litoralis* larvæ have been taken in one of the ponds, but at other times "pure cultures" of *subpictus* larvæ occur in the brackish water and only *litoralis* larvæ just across a dike or embankment in more salty water.[12]

[12] These records apply to the dry season. During the rainy season the fishponds and salt ponds become much diluted. Breeding of *litoralis* appears to be reduced and that of *subpictus* becomes more general.

Subpictus larvæ have not as yet been taken in water with a salt content as high as sea water, the highest salt percentage recorded for them being 2.8. This was in a slowly drying pool and the larvæ were much less abundant than they had been three weeks previously when the water showed only 1.4 per cent salt.

In fresh-water breeding places *indefinitus* larvæ are found in association with one or more of several other common species such as *fuliginosus, barbirostris,* or *ludlowi.* Its occurrence in pure cultures in a different type of breeding place therefore gives the impression of a possibly distinct biological race. In the present study the material from the two sources has been considered separately, and the comparative tabulation of larval and adult characters shows certain variations between the two forms, several of which are at least of statistical significance and others that might be so in larger series.

It may be noted in Table 4 that the fresh-water form gave a larger proportion of specimens with a fringe spot between veins 5.2 and 6 and a slightly larger proportion with incomplete or absent costal sector spots. Statistically significant differences (as shown by the relation to the standard deviation) were found in certain of the larval characters (Table 6) as follows:

Outer occipital hair; 32 per cent 5-branched in the salt-water larvæ compared with 48 per cent in the fresh-water larvæ—a difference of 0.16 ± 0.062.

Thoracic palmate hair; 71 per cent 3-branched compared with 38 per cent in the fresh-water larvæ—a difference of 0.33 ± 0.084.

Palmate I; 15 per cent with 5 or fewer branches compared with 3 per cent—a difference of 0.12 ± 0.032.

Antepalmate VII; 3 per cent 4-branched compared with 13 per cent—a difference of 0.10 ± 0.03.

The measurements of certain characters shown in Tables 2 and 5 are, however, almost identical and no decided characteristics that would justify their separation have as yet been noted. Variations somewhat comparable to those given above may sometimes occur in different broods or lots of what are clearly the same species.

ANOPHELES VAGUS var. LIMOSUS var. nov.

The separation of the Philippine form of this species as a variety of the type form from Java seems justified on the differences in the posterior clypeal hairs of the larvæ. The description and illustrations of Swellengrebel (1919) and others

show these hairs to be much closer together than the inner anterior clypeals and placed well forward on the clypeus. Two or three larval specimens recently received from Java through the kindness of Doctor Soesilo show this placement clearly. The illustration (fig. 2, *d*) was drawn from one of these. In variety *limosus* the postclypeal hairs arise much farther back and are nearly in line with or sometimes slightly closer together than the inner anterior clypeals. Sufficient material for a more detailed comparison of the larvæ or adults of the type form is not available at the present time.

Female.—Palpal black band narrower than in var. *indefinitus* in the majority of specimens but is variable and not by itself a dependable diagnostic character; proboscis without the white spot just back of the flabella that is said to occur in the type form; subapical black costal spot of wing (Plate 2, fig. 1) almost always shorter than one, usually both, of the adjoining white spots and frequently very much reduced, averaging only slightly more than one-fourth of the total area of the three spots; subcostal white spot usually as long as or longer than subapical white; accessory sector spot on subcosta sometimes present; sector spot and accessory sector spots on vein 1 continuous in 11 per cent of the specimens; presector black spot on vein 1 less than half as long as the costal spot above it in two-thirds (68 per cent) of the specimens, sometimes entirely absent, as compared with var. *indefinitus* in which this spot is very seldom less than half as long as the costal spot; two white basal costal interruptions present in all specimens; basal dark spot seldom with white scales on anterior margin; fringe spot between veins 5.2 and 6 in 54 per cent of the specimens.

Fore tarsi of male usually without a basal white band on segment 4 and sometimes without apical band on segment 3 (similar in this respect to the banding in the type form as shown by Rodenwaldt, 1922).

Male genitalia.—Leaflets of the mesosome (Plate 3, fig. 4, and Plate 4, fig. 4) differ in size and shape from any of the other Philippine species in this group but appear to be similar to those of the type form of *vagus* from Java and as described by Christophers (1915) for Indian specimens. The group on each side consists usually of four stout, straight leaflets, the first one very long, the others progressively much shorter. In addition there are usually one or two, sometimes more, short irregular spikes at the base and occasionally a longer slender leaflet. The longest leaflet averaged 68 μ in length and the

TABLE 6.—*Comparative branching of larval hairs and measurements of palmate leaflets in several species of Anopheles.*

	Anopheles litoralis.		*Anopheles ludlowi.*		*Anopheles parangensis.*		*Anopheles subpictus* var. *indefinitus.* Brackish water.		*Anopheles subpictus* var. *indefinitus.* Fresh water.		*Anopheles vagus* var. *limosus.*	
	Number.	Per-cent.	Number.	Per-cent.	Number.	Per-cent.	Number.	Per-cent.	Number.	Per-cent.	Number.	Per-cent.
Larval specimens examined [a]	129	------	99	------	22	------	68	------	66	------	96	------
Inner occipital hair:												
Variation (in branching) [b]	1–3	------	1–3	------	1–2	------	1–4	------	1–3	------	1–3	------
Usual	1	96	1	96	1	88	1	98	1	96	1	95
Outer occipital hair:												
Variation	1–5	------	2–7	------	3–5	------	3–6	------	3–7	------	3–9	------
Usual	3–2	89	4–5–3	91	4–5–3	100	4	46	5	48	5	39
	3 or less	97	4 or more	77	------	------	5	32	4	31	6	36
Anterior thoracic hairs:												
Inner	2–11	------	8–16	------	12–20	------	7–16	------	9–16	------	10–18	------
Average	6.7	------	12.3	------	16.7	------	11.5	------	13.2	------	13.4	------
Usual	8 or less	91	10 or more	92	15 or more	85	9–14	88	10–15	88	11–17	92
Middle	2–10	------	8–14	------	12–19	------	6–15	------	9–16	------	9–17	------
Average	6.0	------	10.1	------	15.4	------	11.3	------	12.2	------	12.4	------
Usual	8 or less	91	9 or more	94	14 or more	84	------	------	------	------	------	------
Thoracic "palmate" hair:												
Variation	1–4	------	2–6	------	3–7	------	2–5	------	2–5	------	1–6	------
Average	2.3	------	3.6	------	5.0	------	3.2	------	3.7	------	2.9	------
Usual	3–2	83	4–3	67	------	------	3	71	4	43	3	53
	3 or less	99	4 or more	52	------	------	4	19	3	38	2	25
Abdominal palmate, segment I:												
Variation	3–9	------	2–6	------	8–12	------	4–11	------	5–11	------	2–8	------
Average	5.3	------	3.2	------	10.5	------	7.0	------	7.6	------	5.0	------
Usual	5–6–4	77	3–4–2	93	11–10	68	7–8–6	72	8–7–6	74	5–6–4	80
	6 or more	43	5 or less	99	------	------	6 or more	85	6 or more	97	5 or less	71

Antepalmate hairs:												
Segment II	2–5	------	2–6	------	3–4	------	3–6	------	3–6	------	2–5	------
Usual	3	76	3–4	88	3	76	4–5	80	4–5	81	3	79
Segment III	2–4	------	2–5	------	3–4	------	3–5	------	2–6	------	2–4	------
Usual	3	98	3	89	3	95	3	84	3	81	3	95
Segments IV and V	1–3	------	1–2	------	1	------	1–2	------	1–2	------	1–2	------
Usual	1	98	1	99	1	100	1	96	1	99	1	99
Segment VI	1–3	------	1–2	------	1–3	------	1–3	------	1–3	------	1–4	------
Usual	1	53	1	94	1	98	1	81	1	90	2	41
	2	34		------		------		------		------	3	36
Segment VII	2–5	------	1–4	------	3–5	------	1–4	------	2–4	------	2–7	------
Usual	3	92	3	80	4–5	88	3	90	3	84	4	46
							4	3	4	13	3	33
Lateral abdominal hairs:												
Segment IV	2–6	------	2–6	------	2–4	------	2–4	------	2–4	------	2–4	------
Usual	3	85	4	50	3	95	3	87	3	85	2	55
	2	9	3	44			2	9	2	8	3	44
Segments V and VI	2–5	------	2–5	------	2–4	------	2–4	------	2–4	------	2–4	------
Usual	3	83	3	74	3	90	3	83	3	88	3	70
Measurements of leaflets of palmate IV:												
Number of measurements	50	------	50	------	30	------	50	------	50	------	50	------
Filament, average length..mm	0.036	------	0.031	------	0.053	------	0.047	------	0.047	------	0.023	------
Blade, average length.....mm	0.039	------	0.035	------	0.041	------	0.051	------	0.055	------	0.041	------
Total, average length.....mm	0.075	------	0.066	------	0.094	------	0.098	------	0.102	------	0.064	------

[a] Both hairs in each pair were counted in the majority of specimens, except the anterior thoracic hairs and the thoracic palmate hairs which were recorded for only a part of the specimens.

[b] Simple hairs indicated by figure "1."

measurements made of the four main leaflets in a typical group were 67–51–36–21 μ.

When the mesosome is separated from the hypopygium and mounted separately the leaflets frequently show fine serrations along the sides as in fig. 4, Plate 4. (See footnote 10.)

Larva.—Clypeal hairs (fig. 2, *c*) usually simple, sometimes forked, the outer short, about one-third the length of the inner; the posterior slightly longer than the outer and normally extend only a short distance beyond the base of the inner but not beyond the front margin of the clypeus; they are placed well back on the clypeus and are as widely or nearly as widely separated as the inner hairs. In the type form the posterior hairs are only about one-third their own length back of the inner and their bases are much closer together (fig. 2, *d*). Anterior submedian thoracic hairs and antepalmate hairs of segments III, IV, and V similar to var. *indefinitus;* thoracic palmate with an average of about three (2.9) hairlike branches; palmate I with an average of five hairlike or slightly broadened branches (fig. 4, *d*); antepalmate hairs of segment II usually 3-branched; those of segment VI usually 2- or 3-branched instead of simple as in other members of the group; about half (55 per cent) of the lateral abdominal hairs of segment IV 2-branched (instead of the normal three)—one or both of the hairs 2-branched in 74 per cent of the individual specimens; average ratio of filament to blade of the leaflets of palmate IV about 0.56; leaflets (fig. 5, *b*) narrower than and about two-thirds (64 per cent) the total length of those in var. *indefinitus;* pecten with short and long teeth of distinctly different lengths (fig. 6, *d*).

Type female.—Reared from larva collected at Balintawak, Rizal, Luzon, January 15, 1929.

The typical breeding place of the species is a small muddy unshaded pool without aquatic vegetation.

Summary of the principal distinguishing characters of the Philippine species of the Pseudomyzomyia group.

ADULTS

1. Legs speckled .... 2.
   Legs not speckled .... 4.
2. Female; sixth vein of wing with two dark spots, no pale fringe spot between forks of vein 5, subapical black costal spot of about the same length as the white areas on either side.
   Male genitalia of normal *Myzomyia* type with a group of four or five spines in the parabasal area of the side piece........................ 3.

Vein 6 with three dark spots; pale fringe spot between forks of vein 5; subapical costal black spot very short.

Side piece of male genitalia without the normal group of parabasal spines; a long and a short unmodified hair in this area and internally a large spoon-shaped organ arising from a tubercle; mesosome with a bulbous membrane bearing modified leaflets; claspette (harpago) with a long fingerlike extension................ *A. parangensis.*

3. Sector spot of wing costa frequently absent or incomplete; basal dark spot of costa usually with white scaling on anterior margin, sometimes forming a complete prehumeral white spot; two dark spots on vein 1 under mid-costal area; vein 2 without a separate patch of dark scales at fork; legs usually yellowish scaled ventrally and segments 3 and 4 of mid tarsi, often segment 2, with narrow basal as well as apical pale bands. Fossa of mesonotum with scattered broad flat scales (about six to ten in number).

Mesosome with eight to fourteen leaflets, subequal in length, some of them flattened and blade-shaped, the longest about 42 μ.... *A. litoralis.*

Costal sector spot present; basal dark spot of costa without white scaling on anterior margin; three dark spots on vein 1 under the midcostal area and a dark patch of scales at fork of vein 2 frequently present; legs, except for speckling, mostly dark scaled ventrally as well as dorsally; segments of mid and hind tarsi usually without basal pale bands. Apical white palpal band frequently divided into two by an additional narrow black band at the base of the apical segment.

Mesosome with three or four main leaflets on each side besides a few short spikes; the first leaflet stout, S-shaped and broadest near base with prominent serrations, the next two or three leaflets progressively shorter; length of longest about 53 μ................ *A. ludlowi.*

4. Female wing with subapical costal black spot usually distinctly shorter than the white spots on either side, particularly the subcostal spot; presector dark spot on vein 1 usually less than half as long as the costal spot above, sometimes absent; costal dark spot at base of wing without white scales on anterior margin; preapical palpal black band narrow, averaging about one-third the length of the apical white.

Mesosome with four or five stout leaflets and one or more short spikes on each side; the first leaflet straight and very long, the next three or four progressively shorter; length of long leaflet about 68 μ.

A. vagus var. *limosus.*

Subapical costal black spot usually as long as or longer than the white spot on either side; presector dark spot on vein 1 usually more than half the length of the costal spot above costal dark spot at base of wing often with white scaling on anterior margin; preapical palpal black band averaging about one-half the length of the apical white.

Mesosome with six to thirteen leaflets on each side, short and similar to *litoralis* in shape; length of longest about 36 μ.

A. subpictus var. *indefinitus.*

LARVÆ

1. Outer clypeal hairs one-half or more, the length of the inner.................. 2.
   Outer clypeal hairs short, about one-third the length of the inner; palmate of first abdominal segment hairlike; one or both lateral hairs of segment IV 2-branched and antepalmate hair of segment VI, 2- or 3-branched in many of the specimens; pecten usually with short and long teeth of distinctly different lengths.
   A. vagus var. *limosus.*
2. Palmate of segment I with more- or less-developed leaflets terminating in filaments; short teeth of pecten usually about one-half, or less, the length of the long teeth.. 3.
   Palmate I hairlike or, if the hairs are slightly broadened, without differentiated filaments; short and long teeth of pecten of about the same length .... 4.
3. Palmate I usually not fully developed; anterior thoracic hairs usually with less than fifteen branches; pleural hair groups on pro- and mesothorax without feathered hairs........ *A. subpictus* var. *indefinitus.*
   Palmate I small but typically developed; anterior thoracic hairs usually with fifteen or more branches; pleural hair groups on pro- and mesothorax each with one feathered hair............................ *A. parangensis.*
4. Lateral hairs of abdominal segments IV to VI with the first branches arising some distance from the base, the hair on segment IV frequently 4-branched. In the majority of specimens the outer occipital hair has four or more branches, the anterior thoracic hair more than nine branches and the antepalmate hair of segment VI is simple .... *A. ludlowi.*
   Lateral hairs of abdominal segments IV to VI branched near the base, usually with three branches. The outer occipital hair has less than four branches and the anterior thoracic hairs less than nine branches in the majority of specimens while the antepalmate hair of segment VI is bi- or tri-fid about half the time.................... *A. litoralis.*

GENERAL SUMMARY

Five anopheline species of the *Pseudomyzomyia* group, commonly referred to as the *rossi-ludlowi* group, occur in the Philippines. Their principal distinguishing characters are given, together with comparative observations on related species and the conclusions reached in regard to questions of nomenclature. Two speckle-legged forms that have formerly been included under the name *Anopheles ludlowi* Theobald, are shown to be specifically distinct and to differ from the important East Indian species, *Anopheles sundaicus* (also called *ludlowi*). The name *ludlowi* is restricted to the form that, in the Philippines, appears to breed exclusively in fresh water and a new name, *Anopheles litoralis*, is proposed for the local salt-water breeder.

The leaflets of the mesosome of *A. ludlowi* are distinct from those of the other members of the group, while the leaflets of *sundaicus* and *litoralis* (as well as the Philippine *subpictus*) are more nearly alike. *Anopheles sundaicus* differs from both *ludlowi* and *litoralis* in the relative lengths of the stem and forks of wing vein 2, and, as shown by Rodenwaldt for *ludlowi*, in the proportion of black- to white-scaled areas on the costa and vein 5.1, as well as in certain other wing markings.

Although *sundaicus* is an important carrier of malaria in Java and elsewhere, the salt-water form in the Philippines is not known to be of any importance in this respect. These two species evidently differ also in regard to the concentration of salt required to produce the most favorable breeding conditions. *Anopheles sundaicus* is said to thrive best in water containing less than 2 per cent salt, while *litoralis* is found breeding most prolifically in water of about the salinity of sea water (from 3 to 4 per cent) or higher. They have been collected in water containing as high as 7.4 per cent salt (about 27 per cent of saturation).

The Philippine form of *Anopheles subpictus* Grassi differs from the type form from India in the leaflets of the mesosome as well as in certain wing characters. While the evidence indicates that it is a distinct species, it is retained for the present as a variety, *Anopheles subpictus* var. *indefinitus* Ludlow, to avoid the confusion that might otherwise arise due to the previous misapplication of the name to *Anopheles vagus*.

Larvæ of var. *indefinitus* are found in brackish as well as fresh water. Although minor variations occur in material from the two sources, no distinctive differences sufficient to justify their separation have been observed.

The Philippine form of *Anopheles vagus* is separable from the East Indian type form on the position of the posterior clypeal hairs of the larva. It is therefore described under a new varietal name, *A. vagus* var. *limosus*. The leaflets of the mesosome of this variety are distinct from those of the other Philippine species.

Anopheles parangensis, a very much speckled species with a southern distribution, differs from the other members of the group, especially in the thoracic pleural hairs of the larva and in the male genitalia. The latter, as shown by Rodenwaldt, are unique in that they lack the typical parabasal spines but possess

a large spoon-shaped organ on the side pieces and a fingerlike extension of the claspettes (harpagones). A peculiar membrane with modified leaflets, that has not previously been described, is found to be attached to the mesosome.

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ERRATA

In a previous article on the "Philippine varieties of *Anopheles gigas* and *Anopheles lindesayi*," Philip. Journn. Sci. 46 (1931) 751–757, the figure numbers for the illustrations of the leaflets of the mesosome (Plate 2) have been reversed. As now numbered, fig. 3 should read "*Anopheles lindesayi* var. *benguetensis*" and fig. 4, "*Anopheles gigas* var. *formosus*."

For "antipalmate" on pp. 752 and 755 read antepalmate.

Attention may also be called to the fact that, in the illustrations of the wings of the two species, some of the white spots have not been reproduced clearly, especially the fringe spot between veins 5.2 and 6 in fig. 1 (var. *formosus*), the long white spot on the apical half of vein 6 and the small spot in the center of vein 2.1. Vein 5.2, which appears to be somewhat pale is actually dark.

In fig. 2 (var. *benguetensis*) all of the white spots with the exception of the fringe spots at the ends of veins 4.2 and 6 are considerably more contrasting in the original than they appear in the illustration.

ILLUSTRATIONS

Plate 1. Female Wings

Fig. 1. *Anopheles ludlowi*, with costa of another specimen showing two spots on vein 1 under the midcostal spot and an accessory sector spot on the subcosta.

2. *Anopheles litoralis*, with costa of another specimen showing an accessory sector spot on the subcosta, a complete sector spot and a patch of white scales on the anterior margin of the basal black spot.

3. *Anopheles sundaicus*.

Plate 2. Female Wings

Fig. 1. *Anopheles vagus* var. *limosus*, with costa of another specimen showing a very short subapical dark spot, one dark spot on vein 1 under the midcosta, and a short presector dark spot on vein 1.

2. *Anopheles subpictus* var. *indefinitus*.

3. *Anopheles subpictus*; type form from India. (This specimen lacks the fringe spot usually present between veins 5.2 and 6.)

4. *Anopheles parangensis*.

Plate 3

Fig. 1. *Anopheles litoralis*; leaflets of mesosome (ædeagus).

2. *Anopheles subpictus* var. *indefinitus*; leaflets of mesosome.

3. *Anopheles ludlowi*; leaflets of mesosome, showing on the right side the typical shape of the long leaflet.

4. *Anopheles vagus* var. *limosus*; leaflets of mesosome.

5. *Anopheles parangensis*; *a*, base of side piece; *b*, expanded organ on the side piece, drawn from an unmounted specimen; *c*, mesosome and claspette.

Plate 4

Leaflets from one side of mesosome, at higher magnification, to show shape and serrations. (Originally drawn at a magnification of × 2,500.)

Fig. 1. *Anopheles litoralis*.

2. *Anopheles subpictus* var. *indefinitus*.

3. *Anopheles ludlowi*.

4. *Anopheles vagus* var. *limosus*.

5. *Anopheles subpictus*; type form from India.

TEXT FIGURES

FIG. 1. Terms employed to designate the costal wing spots. Most of the names have been adapted from those used by S. R. Christophers and others.

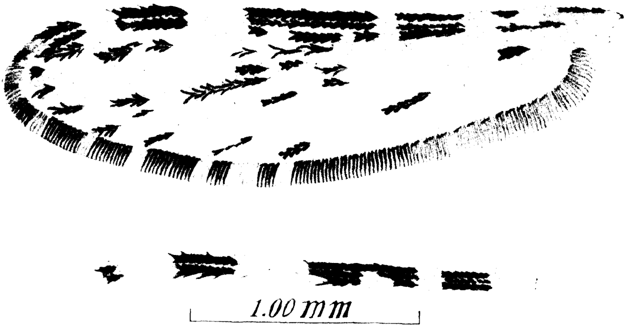
2. Larval clypeal hairs; *a, Anopheles litoralis; b, Anopheles subpictus* var. *indefinitus* (also similar to *A. ludlowi*); *c, Anopheles vagus* var. *limosus; d, Anopheles vagus,* type form from Java; *e, Anopheles parangensis.*

3. Anterior submedian thoracic hairs; *a, Anopheles litoralis; b, Anopheles subpictus* var. *indefinitus* (also similar to *A. ludlowi* and *A. vagus* var. *limosus*); *c, Anopheles parangensis.*

4. Palmate hairs of first abdominal segment; *a, Anopheles subpictus* var. *indefinitus; b, Anopheles parangensis; c, Anopheles ludlowi; d, Anopheles vagus* var. *limosus; e, Anopheles litoralis.*

5. Leaflets of palmate hairs from abdominal segment IV (*a* to *d*) and lateral hairs from same segment (*e* and *f*); *a, Anopheles litoralis; b, Anopheles vagus* var. *limosus; c, Anopheles parangensis; d, Anopheles subpictus* var. *indefinitus; e, Anopheles litoralis,* lateral hair; *f, Anopheles ludlowi.*

6. Pectens of eighth abdominal segment; *a, Anopheles litoralis; b, Anopheles subpictus* var. *indefinitus; c, Anopheles ludlowi; d, Anopheles vagus* var. *limosus; e, Anopheles parangensis.*



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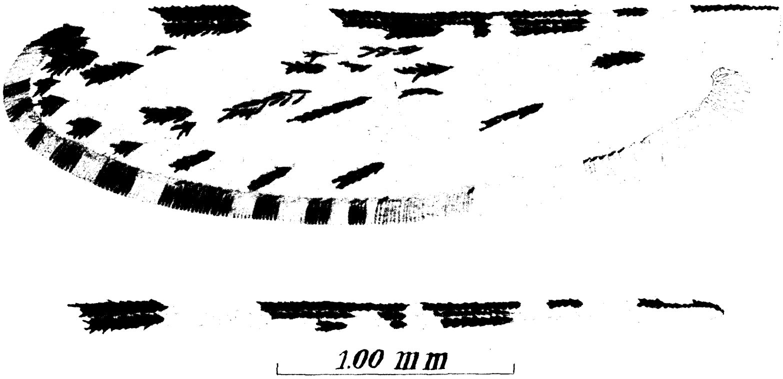

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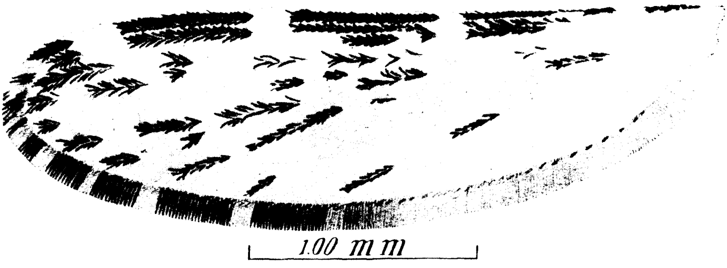

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PLATE 1.

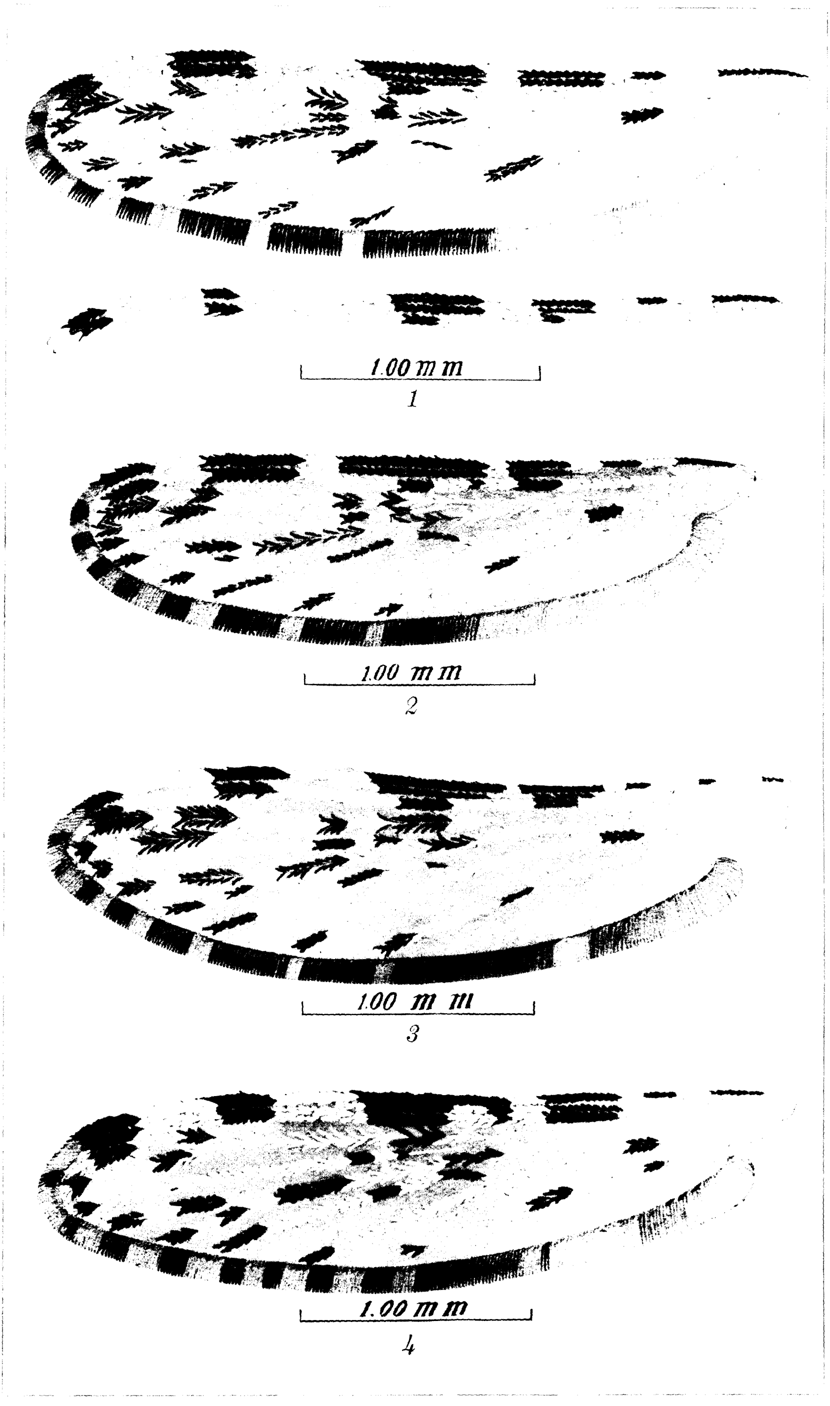

PLATE 2.

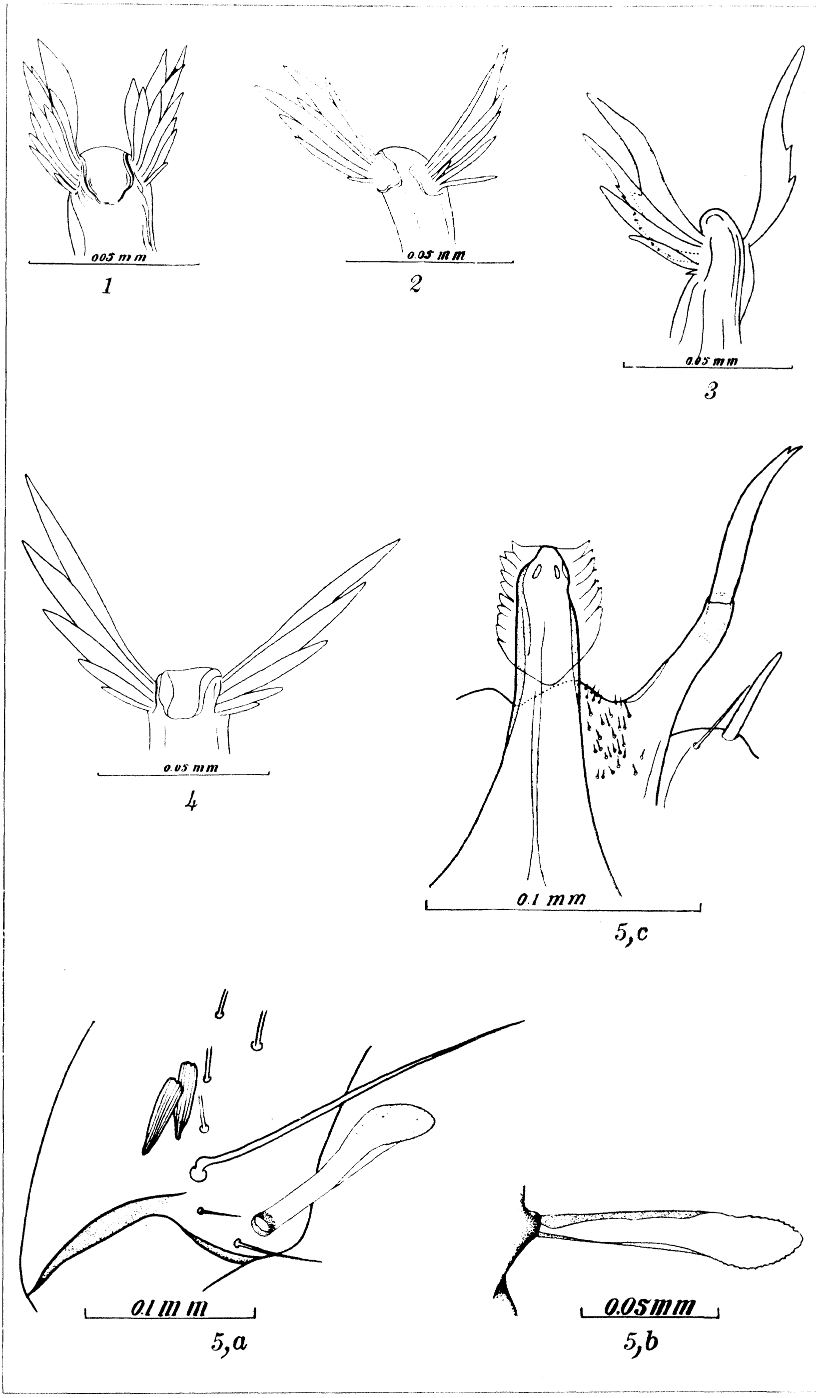

PLATE 3.

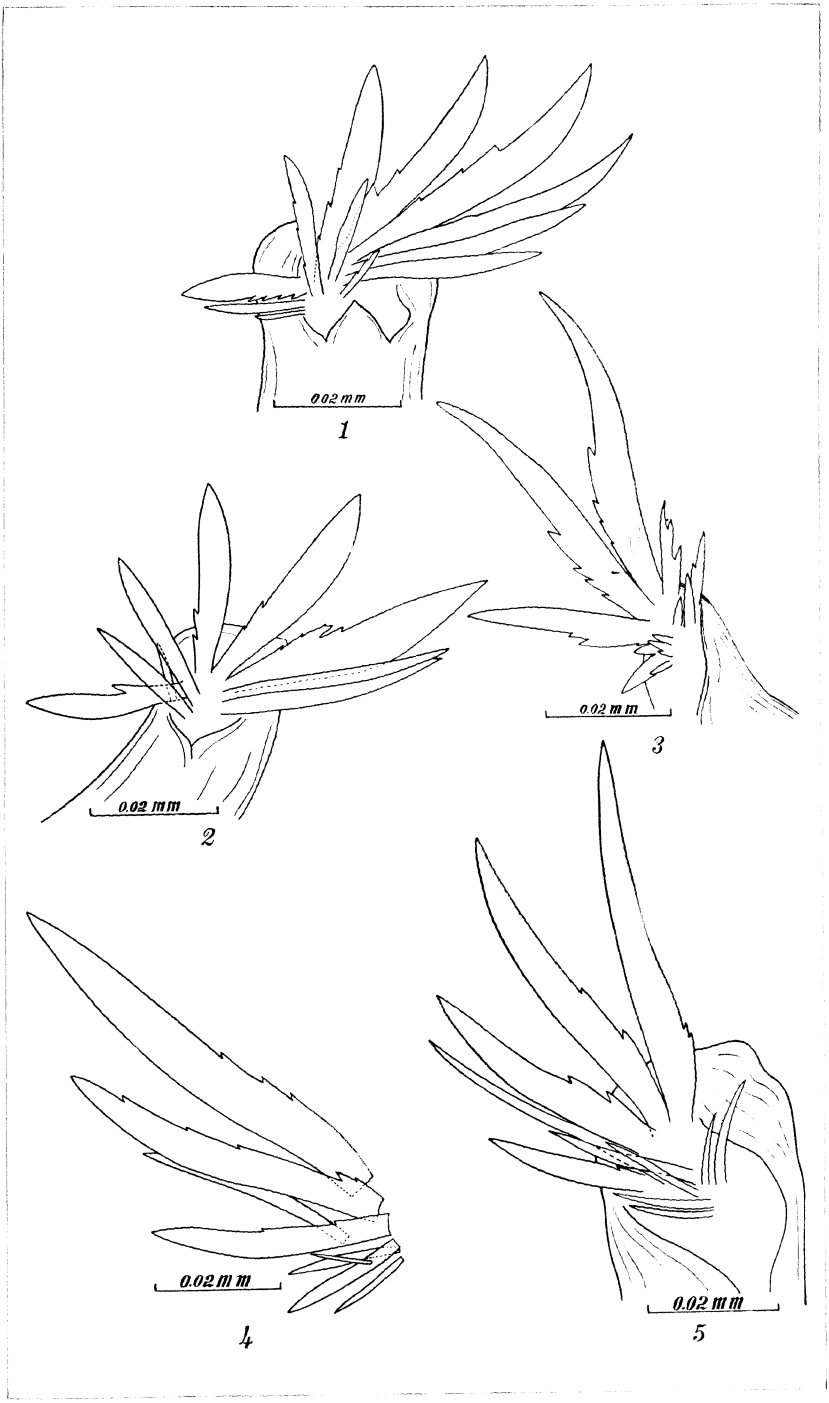

PLATE 4.

THE COMPOSITION OF PHILIPPINE WOODS, II

ANUBING, BALAKAT, MALAIKMO, BALAKAT-GUBAT BOLONGETA, AND SANTOL

By F. M. YENKO, LUZ BAENS, and AUGUSTUS P. WEST
Of the Bureau of Science, Manila

and

H. M. CURRAN
Of the Bureau of Forestry, Manila

THREE PLATES

The virgin forests of the Philippines cover about 40,000 square miles and in addition there are about 20,000 square miles of second-growth forests.[1] Considerable portions of these forests are easily accessible for logging and as a result there are a number of sawmills now in operation.

The sawdust and other waste wood produced at these numerous sawmills are at present used merely as fuel. Some of this waste material may contain sufficient cellulose suitable for the manufacture of various commercial products.

Industries such as those that manufacture rayon and other products from cellulose use wood as their basic raw material. For such industries the composition of woods is a matter of considerable importance. It has been estimated that in the Philippines there are more than 2,500 species of trees. This is a much larger number than is found in all of the United States and Canada combined. As yet no systematic chemical analysis of tree species growing in the Philippines has been made. It therefore seemed desirable to analyze some of the commoner and better-known types of trees.

[1] Whitford, H. N., Bull. Philip. Bur. For. 10 (1911) 1.

Considerable data concerning the forests of the Philippines, species of trees, characteristics of the wood, and minor forest products have been published.[2]

EXPERIMENTAL PROCEDURE

The trees we have analyzed have the common names anubing, balakat, malaikmo, balakat-gubat, bolongeta, and santol. An account of the structure of these trees, local names, and general properties is given by Schneider.[3] According to Schneider[4] the durability of Philippine woods is divided into four classes which he describes in the following manner:

1. Very durable, for example, anubing, ipil, mancono, molave. Such woods are probably rarely attacked by insects, except after they have been softened by decay—that is, by attacks of fungi after long exposure to exceptionally severe conditions. They resist exposure to the weather or contact with the ground for long periods. All timbers in this class are believed to be at least equal to the most durable American woods and many of them surpass in durability any commercial timber of the temperate zone.
2. Durable, for example, calamansanay, palomaria, tindalo, tucang-calao. These woods are very rarely attacked by any insects and will last many years even in contact with the ground or exposed to the weather.

[2] Whitford, H. N., The Forests of the Philippines, Bull. P. I. Bur. Forestry 10 (1911).

Whitford, H. N., Philip. Journ. Sci. 1 (1906) 373; 637.

Brown, W. H., and D. M. Matthews, Philip. Journ. Sci. § A 9 (1914) 413.

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Brown, W. H., Minor Products of Philippine Forests, Bull. P. I. Bur. Forestry 22 1 (1920); 2 (1921); 3 (1921).

[3] Bull. P. I. Bur. Forestry 14 (1916).

[4] Op. cit. 87.

3. Fairly durable, for example, apitong, guijo, kalumpit, catmon. Woods of this class are not commonly or severely attacked by insects. They resist the weather fairly well and last several years even in the ground. Most of the woods in this class would, it is believed, compare with the woods of average durability in the North Temperate Zone.

4. Not durable. These woods although not termite proof are not specially subject to attacks of other insects—that is to say, they are not invariably attacked as are certain other woods; but the sapwood is often poor in this respect and woods of this class unprotected by paint or preservatives should not be exposed to conditions of constant moisture or of constant alternation between moisture and dryness. Thus, they are not recommended for use in the ground or for exposure to the weather, when woods of the other classes are available. There is included in this class no wood believed to be inferior to the medium-grade construction timbers of the United States and the classification has been made with special reference to Oregon pine and California redwood, which are the woods most commonly imported into the Philippines. The various lauans, which form the great bulk of the timber of this class, are mechanically stronger than redwood and Oregon pine. Redwood is by no means immune to the attacks of termites, while Oregon pine is known to be destroyed by them in a comparatively short time.

Certain woods which are known to be less resistant than the lauans to decay and insects, have their degree of durability designated, not by numbers, but by such phrases as "durability poor," "often attacked by beetles," etc.

Brief descriptions of the Philippine woods analyzed in this investigation follow.

Anubing (*Artocarpus cumingiana* Trec.) sometimes grows to a diameter of 100 centimeters. The wood is hard and heavy and is difficult to work as it dulls tools very rapidly. Although it checks but little it is liable to warp if not carefully seasoned. It has a durability of 1 and is rarely attacked even by termites. It is used for piling, ships, bridges, poles, beams, mine timbers, ties, and paving blocks.

Balakat [*Ziziphus talanai* (Blco.)] is moderately hard and heavy. It is easy to work, has a durability of 4, and is often attacked by shot-hole borers. It is used for cheap construction, furniture, flooring, agricultural implements, and wooden-shoe soles.

Malaikmo [*Celtis philippinensis* (Blco.)] may attain a diameter of 100 centimeters. The wood is moderately hard, heavy, tough, and somewhat difficult to split. It seasons well, is fairly easy to work, has a durability of 3, and is not commonly attacked by insects. It may be used for beams, rafters, boxes, and temporary construction.

Balakat-gubat [*Sapium luzonicum* (Vid.) (Merr.)] is a tree which may reach a diameter of one meter and a height of 30

meters. It is a soft wood and is sometimes used in general construction work.

Bolongeta [*Diospyros pilosantera* (Blco.)] is very widely distributed and grows to a diameter of 50 centimeters. The wood is very similar to camagon. It is hard, heavy, and has a high specific gravity. It is difficult to season and to work but takes a beautiful finish under sharp tools. The heartwood has a durability of 1 and the sapwood 2. The wood is used for numerous purposes such as beams, rafters, musical instruments, cabinetwork and furniture.

Santol [*Sandoricum koetjape* (Merr.)] grows to a diameter of 70 centimeters or more, is widely distributed, and is one of the best known trees in the Philippines. The wood is soft and light. It seasons well, is easy to work, and has a durability of 3. Santol is used for carving sacred images. It is also employed for light framing, ceilings, household implements, and furniture.

The measurements of the trees used for our analysis are given in Table 1. They were all sound trees and representative specimens of their particular species. Although we analyzed wood samples from trees of different sizes yet they were all mature trees. In a recent investigation of Philippine bagtikan trees [5] it was found that the analysis of the individual mature trees, whether small or of medium size, was about the same for the principal constituents. If it is assumed that other species of trees give results like those obtained with bagtikan then the wood samples analyzed in this investigation are really representative of the individual species.

TABLE 1.—*Measurements of Philippine trees used for wood analysis.*

Measurement.	Anubing.	Balakat.	Malaikmo.	Balakat-gubat.	Bolongeta.	Santol.
Diameter cm	29.0	43.0	26.0	45.0	24.0	32.0
Total height m	16.5	18.2	18.19	22.59	22.0	19.75
Clear length of trunk m	8.0	10.8	10	------	------	------
Cut above ground m	2.05	2.19	2.13	1.64	4.64	4.75

In analyzing the wood samples we used the standard methods adopted by the United States forest-products laboratory at Madison, Wisconsin.[6] For moisture, cold-water soluble, alkali

[5] Yenko, F. M., Luz Baens, Augustus P. West, and H. M. Curran, Philip. Journ. Sci. 47 (1932) 281.

[6] Bray, M. W., Paper Trade Journ. 87 (1928) No. 25, 59.

Schorger, A. W., Chemistry of Cellulose and Wood (1926) 505.

soluble, ether and alcohol extracts, ash, and nitrogen we followed, in general, the methods given by Schorger. In determining the cellulose, lignin, alpha cellulose, and hot-water soluble material we used the same procedures employed in a recent investigation of Philippine bagtikan woods.[7] These procedures were slight modifications of the standard methods.

RESULTS

The results of analyzing the woods recorded in this paper are given in Table 2.

TABLE 2.—*Analysis of Philippine woods.*

Constituent.	Anubing.	Balakat.	Malaikmo.	Balakat-gubat.	Bolongeta.	Santol.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	9.27	8.65	8.91	8.26	8.95	8.30
Cold-water soluble	4.43	4.02	4.08	5.16	3.90	3.38
Hot-water soluble	7.02	5.90	6.95	6.81	7.02	6.07
Alkali soluble	20.42	11.24	13.01	15.97	15.01	18.08
Ether extract	0.68	0.77	0.46	0.24	0.46	2.49
Alcohol extract	6.04	4.28	3.15	7.63	4.23	3.91
Ash	2.26	1.70	1.81	1.62	1.53	0.55
Nitrogen	0.48	0.23	0.45	0.37	0.29	0.27
Cellulose	58.92	52.09	56.99	56.12	54.05	51.37
Ash in cellulose determined	0.80	0.58	0.55	0.65	0.44	0.41
Ash-free cellulose	58.12	51.51	56.44	55.47	53.61	50.96
Lignin	28.98	32.22	27.29	30.84	27.50	28.71
Alpha cellulose	76.38	76.45	75.22	78.37	82.23	77.81

As shown by the data (Table 2) the highest percentage of ash and cellulose was given by the wood from anubing. The percentage of nitrogen was approximately the same for all the woods. Balakat gave the highest percentage of lignin, while bolongeta gave the highest percentage of alpha cellulose.

Compared to some American woods[8] the Philippine woods seem to be more uniform in composition. The Philippine woods contain a somewhat higher percentage of lignin and a slightly lower percentage of cellulose than the American woods. All of these Philippine woods gave a high percentage of alpha cellulose which is an indication that they may be suitable for the manufacture of rayon.

[7] Yenko, F. M., Luz Baens, Augustus P. West, and H. M. Curran, Philip. Journ. Sci. 47 (1932) 281.

[8] Schorger, A. W., Journ. Ind. Eng. Chem. 9 (1917) 556.
Ritter, G. J., and L. C. Fleck, Journ. Ind. Eng. Chem. 14 (1922) 1050.
Mahood, S. A., and D. E. Cable, Journ. Ind. Eng. Chem. 14 (1922) 933.

SUMMARY

Six species of Philippine woods were analyzed in this investigation. They were woods commonly known as anubing, balakat, malaikmo, balakat-gubat, bolongeta, and santol.

The Philippine woods appear to be more uniform in composition than some American woods.

ILLUSTRATIONS

PLATE 1

Balakat. Large tree in the center.

PLATE 2

Santol. Large tree at left, with leaves on the trunk. Same tree as No. 436.

PLATE 3

FIG. 1. Balakat-gubat.
2. Anubing.
3. Bolongeta.
4. Malaikmo.

PLATE 1. BALAKAT.

PLATE 2. SANTOL.

1 2 3 4

PLATE 3.

LEAD, BARIUM, AND MAGNESIUM SALTS OF HYDNOCARPIC AND CHAULMOOGRIC ACIDS[1]

By HOWARD IRVING COLE

Chief Chemist, Culion Leper Colony, Philippine Health Service

Hydnocarpic and chaulmoogric acids in the form of their glyceryl esters are the main constituents of the hydnocarpus-group oils now widely used in the treatment of leprosy. These acids are optically active. They contain a double bond in the pentene ring and are therefore theoretically classed as unsaturated fatty acids. They react in some respects like unsaturated acids, absorbing iodine and bromine in theoretical amounts. On the other hand, being solid acids (melting point 60° and 68° C., respectively), they behave more like saturated fatty acids as regards their physical characteristics. In the ordinary methods of separation of saturated from unsaturated fatty acids based on differences in the solubility of their salts, these two acids appear associated with the former as well as with the latter group. In order, therefore, intelligently to work out a method for the separation of these acids based on the solubility of their metallic salts, some idea as to the relative solubility of these salts is a preliminary necessity. As no data are to be found on this subject in the literature, experiments were performed to determine the solubility of the lead, barium, and magnesium salts in certain solvents at various temperatures.

EXPERIMENTAL

The lead, barium, and magnesium salts of hydnocarpic and chaulmoogric acids were prepared from the pure acids according to the method of Whitemore and Lauro,[2] with some modifications, as follows:

Two grams of the fatty acid were dissolved in 25 cubic centimeters of 95 per cent alcohol and then exactly neutralized with

[1] Published with the approval of the Director of Health.

[2] Journ. Ind. Eng. Chem. 22 (1930) 647.

0.2 N sodium hydroxide with phenolphthalein as indicator. Most of the alcohol was evaporated off and the residue was diluted with water to make 150 cubic centimeters. If any cloudiness appeared, due to hydrolysis, sufficient alcohol was added to clarify the solution and inhibit the formation of acid soaps. A slight excess of lead or barium acetate or magnesium chloride was dissolved in 30 cubic centimeters of water and added slowly, with stirring, to the solution of the alkali soap, this procedure being preferable to adding the alkali soap solution to the solution of the metal salt. Precipitation of the metallic salt or soap occurred immediately. It was allowed to stand about an hour, filtered through paper and then washed with distilled water until the filtrate no longer gave a test for the metal ion. The metallic soaps were dried by spreading out on paper in an oven at 45° C. The lumps were then ground to a fine powder in a mortar, washed with ethyl ether to get rid of any free fatty acid that might be present, then dried to constant weight at 45° and again ground to a fine powder.

Solubility.—Solubility of these salts was determined in ethyl alcohol (95 per cent), ethyl ether, and benzol at 15° C., 30° C., and boiling, and in petroleum ether at 30° C. An excess of the finely powdered salt was vigorously shaken with the solvent for one hour in a constant-temperature bath and then filtered while in the bath as described below. Five cubic centimeters of the solution were evaporated in a weighed porcelain crucible, which was then heated in an oven at 45° C. to constant weight. The results were expressed in grams soluble in 100 cubic centimeters solvent.

Separation of the solution from the undissolved salt was accomplished as follows: The flask is corked with a stopper through which two glass tubes are passed; one, bent at right angles, reaching only to the bottom of the stopper is connected to a rubber bulb with valve, the other of 1 to 1.5 millimeters inside diameter, bent in an inverted U, reaches to the bottom of the flask; the inside end of this tube is plugged lightly with cotton which acts as a filter. Pressure applied by squeezing the bulb forces the filtered liquid out while the temperature of filtration remains constant, the flask being immersed in the constant-temperature bath during the filtration.

TABLE 1.—*Melting points of metallic salts of hydnocarpic and chaulmoogric acids.*

Salt.	Melting point ° C.
Lead hydnocarpate	77–78
Lead chaulmoograte	83
Barium hydnocarpate	120
Barium chaulmoograte	123
Magnesium hydnocarpate	Begins to soften at 80°.
Magnesium chaulmoograte	Begins to soften at 100°.

A generous excess of undissolved salt and vigorous shaking reduces the possibility of supersaturation. One hour was found to be sufficient time for the solvent to reach practical saturation provided the salt was in a finely powdered condition. As this work was undertaken in order to find the relative solubilities of these salts as compared with the similar common fatty acid salts, no attempt was made to obtain ultimate solubilities. The solubilities found will, however, be those encountered in ordinary laboratory analyses of these salts.

The melting points of the salts were determined and are given in Table 1.

The lead and barium hydnocarpates and chaulmoogrates are white, amorphous powders, slightly tacky when ground. The magnesium salts of these acids are voluminous white amorphous powders with no tackiness. The solubilities of all of these salts in the solvents mentioned above, as well as those of lauric, palmitic, stearic, and oleic acids, where available, are given in Tables 2, 3, and 4. The low value obtained for solubility of magnesium hydnocarpate in boiling alcohol is probably due to the fact that the salt begins to soften and agglomerate in the alcohol at about 60° C., thereby offering less surface to the solvent.

CONCLUSIONS

The solubilities of the lead, barium, and magnesium salts of hydnocarpic and chaulmoogric acids in ethyl alcohol, ether, benzol, and petroleum ether have been determined. These solubilities lie in general between those of the corresponding salts of the common saturated (solid) and those of the ordinary unsaturated (liquid) fatty acids.

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An examination of Table 2 shows that the lead salts of these acids may be expected to appear in both the "solid" and "liquid" fractions when any attempt is made to isolate them by the lead-salt-ether method. This expectation is borne out in practice.

Advantage might be taken of the relatively high solubility of the lead salts of hydnocarpic and chaulmoogric acids in hot alcohol to separate them from the lead salts of the saturated fatty acids. Oleic and other liquid fatty acids might be eliminated by extracting with petroleum ether in which the above-mentioned salts are only very sparingly soluble. Experiments leading to such a method of separation are now in progress.

Complete separation of hydnocarpic from chaulmoogric acid by fractional crystallization of their lead, barium, or magnesium salts from the solvents tested would not appear to be possible, owing to the fact that their solubility factors lie too close together.

TABLE 2.—*Solubility of lead salts of fatty acids, in grams per 100 cubic centimeters.*

Lead.	Ethyl alcohol (95 per cent).			Ethyl ether.		
	15° C.	30° C.	Boiling.	15° C.	30° C.	Boiling.
Hydnocarpate	0.11	0.20	1.13	0.16	0.32	0.98
Chaulmoograte	0.08	0.19	0.91	0.05	0.10	0.29
Laurate	[a] 0.0047		[a] 0.235	[b] 0.010		[c] 0.020
Palmitate	[d]		[e] 0.012	[b] 0.010		[e] 0.026
Stearate	[d]		[e] 0.004	[b] 0.007		[f]
Oleate	[g]			[h]		[h]

Lead.	Benzol.			Petroleum ether (30°–60°) 30° C.
	15° C.	30° C.	Boiling.	
Hydnocarpate	0.09	0.15	2.92	0.014
Chaulmoograte	0.05	0.06	2.42	0.008
Laurate	[b] 0.011			[d]
Palmitate	[b] 0.009			[d]
Stearate	[b] 0.008			[d]
Oleate				[h]

[a] Lewkowitsch, 6th ed. 1: 159.
[b] Seidell.
[c] Lewkowitsch, op. cit. 144.
[d] Insoluble, Seidell.
[e] Seidell (at 50° C.).
[f] Insoluble, Lewkowitsch, op. cit. 144.
[g] Slightly soluble, op. cit. 192.
[h] Easily soluble, ibid.

TABLE 3.—*Solubility of barium salts of fatty acids, in grams per 100 cubic centimeters.*

Barium.	Ethyl alcohol (95 per cent).			Ethyl ether.			Benzol.			Petroleum ether (30°–60°)
	15° C.	30° C.	Boiling.	15° C.	30° C.	Boiling.	15° C.	30° C.	Boiling.	30° C.
Hydnocarpate	0.07	0.08	0.39	0.03	0.04	0.06	0.025	0.04	0.13	0.022
Chaulmoograte	0.03	0.05	0.34	0.02	0.02	0.04	0.02	0.03	0.07	0.016
Laurate	0.019		[a] 0.10							
Palmitate	[b] 0.0035		[b] 0.013							
Stearate	([c])		([c])							
Oleate			([d])							

[a] Lewkowitsch, 6th ed. 1: 159.
[b] Op. cit. 163.
[c] Insoluble, op. cit. 169.
[d] Sparingly soluble, op. cit. 191.

TABLE 4.—*Solubility of magnesium salts of fatty acids, in grams per 100 cubic centimeters.*

Magnesium.	Ethyl alcohol (95 per cent).			Ethyl ether.			Benzol.			Petroleum ether (30°–60°)
	15° C.	30° C.	Boiling.	15° C.	30° C.	Boiling.	15° C.	30° C.	Boiling.	30° C.
Hydnocarpate	0.51	0.67	0.56	0.04	0.045	0.036	0.02	0.04	21.42	0.0008
Chaulmoograte	0.37	0.44	0.46	0.02	0.036	0.024	0.01	0.004	20.07	0.0005
Laurate	[a] 1.52		[a] 12.67		[b] 0.015					
Palmitate	[c] 0.034		[c] 0.151		[b] 0.004					
Stearate	[c] 0.017	[d] 0.006			[b] 0.003					
Oleate	[c] 0.17									

[a] Lewkowitsch, 6th ed. 1: 159.
[b] Jacobson and Holmes, Journ. Biol. Chem. 25 (1916) 29 (at 25° C.).
[c] Ibid. (absolute alcohol used).
[d] Thomas and Yu, Journ. Am. Chem. Soc. 45 (1923) 117 (at 25° C.).

REMARK ABOUT ANONAINE

By ALFREDO C. SANTOS

Of the Department of Pharmaceutical Chemistry, School of Pharmacy
University of the Philippines

The formula $C_{17}H_{16}NO_3$, which the writer assigned to anonaine,[1] should be changed to $C_{17}H_{17}NO_3$, because of the uneven sum of the valences in the former. The analytical results then reported; namely, C 72.2, 72.5, 72.8, average, 72.5; H. 5.6, 6.1, 5.7, average, 5.8; N 4.9, 4.8, average, 4.85, agree also very well with $C_{17}H_{17}NO_3$, which requires C 72.1, H 6.0, N 4.9.

Manila, September 15, 1931.

[1] Philip. Journ. Sci. **43** (1930) 561–564; **44** (1931) 409–410.

THE POISONOUS CONSTITUENT OF CORIARIA INTERMEDIA MATSUMURA

By JOAQUIN MARAÑON

Of the Bureau of Science, Manila

THREE PLATES

Coriaria intermedia Matsumura is a shrub from 1 to 3 meters high. Its distribution in the Philippines is limited to the Mountain Province, northern Luzon, where it is known to the Igorots under the vernacular names *buakat, baket,* and *bikit.*(6) The chemical study of this plant is of particular interest owing to the fact that many of the allied species from Europe, New Zealand, Mexico, and Japan have been reported to contain poisonous substances of the picrotoxin group. Thus, coriamyrtin, which is a violent convulsive poison was first isolated by Riban(7) from *Coriaria myrtifolia* Linn. It was also obtained by Yoshitake(5) from *C. japonica* A. Gray. The toxic constituent (tutin) of the tutu poison of New Zealand resembles coriamyrtin in its pharmacological action and was found by Easterfield and Aston(3) in *C. thymifolia* Humb. and Bonpl.[1] They also noted it in *C. ruscifolia* Linn.[2] and in *C. angustissima* Hook. f.

According to Watt(10) several Indian authors state that the leaves of *C. nepalensis* Wall. act as a powerful poison when given in large doses and the seeds sometimes produce symptoms like tetanus.

Concerning *C. intermedia* Matsum. (the only *Coriaria* species known in the Philippines), Santos(9) states that some inhabitants of Trinidad Valley, Mountain Province, informed him of a case of poisoning by this plant. They said that one couple and their two children died after taking a decoction of the fruits and leaves of *C. intermedia,* which they mistook for their native Benguet tea. The poisonous property of *C. intermedia* was

[1] *Coriaria atropurpurea* Moç and Sesse. Index Kewensis 1 (1895) 618.

[2] *Coriaria sarmentosa* Forst. f., *C. arborea* Lindsay, and *C. tutu* Lindsay. Cheeseman, Manual of the New Zealand Flora (1906) 105.

further shown by Wells,(11) who reports the toxic effect produced in a guinea pig after an intraperitoneal injection of 2 cubic centimeters of the plant extract, representing 20 grams of the fresh plant.

As to the chemical nature of the poisonous constituent of *C. intermedia* Matsum., there is so far no investigation that has definitely established the chemical identity and the properties of the active principle of this plant. Wells(11) states that he obtained 69 grams of the crude, poisonous glucoside from 100 kilograms of the fresh plant, but made no further attempt to identify this particular glucoside, nor did he prove that the poisonous property of the plant was directly due to it. It seemed, therefore, advisable to undertake a further study of this plant.

The results of this investigation indicate that the Philippine *Coriaria* contains coriamyrtin, and pharmacological tests have shown that this substance is the poisonous constituent of the plant. Coriamyrtin was found to be present in small quantities in the leaves, stems, and fruits, but more in the fruits than in the other parts. The leaves contain a considerable amount of pyrogallol tannin, and in this respect the plant may be useful as a tanning material like the currier's sumac or redoul of France (*C. myrtifolia* Linn.). Elementary analysis and molecular-weight determination show coriamyrtin from *C. intermedia* Matsum. to have the molecular formula $C_{15}H_{18}O_5$. This is half the formula formerly assigned to this compound by Riban,(7) a difference already pointed out by Easterfield and Aston(3) and recently confirmed by Kariyone and Sato(5) who reinvestigated *C. japonica* A. Gray. Coriamyrtin crystallizes in colorless prisms which appear to be of the monoclinic system (Plates 1, 2, and 3). It dissolves in ether and alcohol but is sparingly soluble in water. It melts at 218° C., is dextrorotatory, and reduces Fehling's solution after it is hydrolyzed with acid. Treated with hydriodic acid and subsequently with an alcoholic solution of potash a purple-red color is obtained. No characteristic osazones are formed when treated, before and after acid hydrolysis, with an excess of phenylhydrazine. It is not hydrolyzed by emulsin, a test which is generally used for the detection of a naturally occurring glucoside. From the data above it would seem that coriamyrtin is apparently not a glucoside.

EXPERIMENTAL

The plant was collected in the neighborhood of Baguio, Mountain Province, Luzon. The leaves, stems, and fruits were air-dried and powdered. The stems and fruits were utilized mainly for the quantitative estimation of the active constituent. The leaves, representing the bulk of the material, were used for the isolation of coriamyrtin required for further experimental data.

Extraction of coriamyrtin.—The method employed for the separation of this compound is essentially that recommended by Riban(8) for *C. myrtifolia* Linn. Since certain modifications were adopted in removing the excess lead in the filtrate and the purification of coriamyrtin, it would seem desirable to describe the method that was followed. Several kilograms of powdered leaves were boiled with water in successive portions and the combined supernatant liquid was filtered. The highly colored filtrate contained a considerable amount of tannin, as shown by the copious blue-black precipitate which was obtained when a portion was tested with ferric salts. For the removal of tannin and other interfering substances, the filtrate was treated successively with a concentrated solution of neutral lead acetate and basic lead acetate. The precipitate was removed by filtering and washed well with water. The washings were added to the filtrate. The yellow precipitate was suspended in water and the lead compound decomposed by hydrogen sulphide. The aqueous solution obtained, after removal of the lead sulphide, was concentrated on a water bath, allowed to cool, and then extracted several times with ether. The resulting greenish yellow ether solution was distilled and the crystalline residue redissolved in a small amount of ether. The solution upon evaporation gave yellow crystals, which were purified by first dissolving them in methyl alcohol and then decolorizing the solution with purified animal charcoal. The pure substance thus obtained crystallized in colorless, silky needles. The crystals melted at 220° C., reduced Fehling's solution readily, and responded to the usual color reactions of gallic acid. The determination of the molecular weight from the neutralization value gave the following results:

	Neutralization value.	Molecular weight.
Calculated for gallic acid ($C_7H_6O_5$)	329.4	170
Found	322.8	173.8
Do	323.9	173.2

The filtrate and washings from the lead precipitate were treated with potassium oxalate to eliminate the excess lead salts, and then decolorized with Merck's extra pure animal charcoal. The clear aqueous solution thus obtained, when tested with ferric chloride solution, gave a negative result for the presence of tannin. This solution was then evaporated to a small volume on a water bath, cooled to room temperature, and the concentrated solution extracted several times with ether. The combined ether extracts were treated with anhydrous sodium sulphate and filtered. The filtrate was distilled, and the residual crystalline mass was redissolved in a small amount of ether. Upon evaporation, yellowish white crystals were obtained. These were recrystallized twice from ether and further purified by dissolving them in methyl alcohol and treating the solution with a very small amount of Merck's charcoal. The purified substance was obtained as colorless crystals melting at 218° C. From ether and ethyl alcohol the crystals separate in short needles or clusters of radiating prisms; from methyl alcohol, in aggregates of fine monoclinic prisms in dentritic form; and from water, in acicular or prismatic monoclinic crystals. They are soluble in ether and alcohol but dissolve sparingly in water. They do not respond to the alkaloidal tests and contain no nitrogen. They were identified as coriamyrtin from an elementary microanalysis [3] and a molecular-weight determination by the Rast method.(4)

	Carbon.	Hydrogen.	Molecular weight.
	Per cent.	*Per cent.*	
Calculated for $C_{15}H_{18}O_5$	64.76	6.47	280
Found	63.95	6.47	278.3
Do	63.53	6.72	277.3

A determination of the specific rotation in alcoholic solution using a 50-millimeter tube gave $\left(A\frac{30^\circ\ C.}{D}\right) + 42.68^\circ$.

Qualitative tests for coriamyrtin gave the following results: An aqueous solution did not produce a blue black or greenish coloration with ferric chloride. A greenish brown color was observed when a few crystals were moistened with concentrated

[3] The writer is indebted to Dr. Alfredo Santos, of the School of Pharmacy, University of the Philippines, for the elementary analysis of the substance.

sulphuric acid. Potassium permanganate solution was decolorized, and when treated with alcoholic potassium hydroxide no color was developed.

Riban's sensitive test(8) for coriamyrtin gave a positive reaction. This test consists in moistening a few crystals of the substance with concentrated hydriodic acid and evaporating on a water bath. When the residue is dissolved in alcoholic potassium hydroxide an intense purple-red color is developed. This color is destroyed by the addition of water.

In order to determine if the substance is a glucoside, the following experiments were performed:

1. (*a*) An aqueous solution containing 0.0144 gram of the substance was boiled with Fehling's solution and the amount of the cuprous oxide was determined according to the procedure of Munson and Walker(12) for the determination of reducing sugars.

1. (*b*) Another aliquot portion of the solution, equivalent to 0.0144 gram of the substance, was hydrolyzed with dilute sulphuric acid and then neutralized with sodium carbonate. The reduction with Fehling's solution was estimated in the same manner as in (*a*).

1. (*c*) A blank determination, consisting of the Fehling's solution alone, was also made.

	Cuprous oxide. Gram.
Before acid hydrolysis	0.0031
After acid hydrolysis	0.0076
Blank determination	0.0031

2. To individual flasks, each containing 0.015 gram of the coriamyrtin in aqueous solution, were added 10 cubic centimeters of emulsin solution (0.5 per cent), and the mixtures were incubated overnight at 37° C. The reducing sugars were then determined according to the method used in test 1 above. A blank determination was also made by simply heating the solution of coriamyrtin and emulsin on a boiling-water bath for one hour and then determining the reducing sugars in the usual manner. In each case no increase in the reduction of Fehling's solution was noted. (Cuprous oxide obtained was 0.0073 gram.) The activity of the Kahlbaum emulsin was first tested with amygdalin and found to be active.

3. A few milligrams of the coriamyrtin were dissolved in dilute hydrochloric acid. The solution was boiled for a few min-

utes, neutralized with sodium carbonate, and tested for osazones. An amorphous precipitate, soluble in ether, was obtained, indicating the absence of osazones.

From these experiments it would appear that coriamyrtin is not a glucoside, for it failed to produce the characteristic osazone and was not hydrolyzed by emulsin. As shown by Bourquelot,(1) emulsin hydrolyzes the beta glucosides. All naturally occurring glucosides, so far as is known, occur only in the beta form. The slight reduction of Fehling's solution when it was boiled with coriamyrtin (previously hydrolyzed with acid) does not necessarily mean that coriamyrtin is a glucoside. Any aliphatic substance containing a potentially active aldehyde or ketone group has a reducing property. Kariyone and Sato,(5) who obtained coriamyrtin (from *C. japonica* A. Gray), are also of the opinion that this substance is not a glucoside. Possibly coriamyrtin may be assigned to the undefined group called "Corps neutres."

For the quantitative estimation of coriamyrtin in leaves, stems, and fruits, the method described above for the extraction of coriamyrtin from the leaves was followed. The results, calculated on a moisture-free basis, showed that the fruits contained 0.176 per cent of the active constituent, the leaves 0.069 per cent, and the stems, 0.041 per cent.

A tannin determination in the leaves according to Lowenthal-Proctor's method(2) gave 29.00 per cent tannin computed on a moisture-free basis. The tannin belongs to the pyrogallol group as shown by the dark blue color with ferric chloride and by the absence of a precipitate with bromine water.

The poisonous property of the plant and of the isolated coriamyrtin was tested as follows:[4]

1. Two cubic centimeters of the concentrated plant extract, representing 1 gram of the dried powdered leaves, were injected subcutaneously into a guinea pig weighing 420 grams. The animal suffered clonic convulsions five minutes after the injection and died twenty minutes after.

2. Three guinea pigs, weighing 174, 184, and 190 grams, respectively, were each injected subcutaneously with 0.5 cubic centimeter of the aqueous solution of coriamyrtin (equivalent to 0.7 milligram of coriamyrtin). One minute after the injection there was a violent emprosthonic convulsion, which was fol-

[4] The writer desires to thank Dr. Onofre Garcia, of the Bureau of Science, for assistance with these experiments.

lowed by clonic movements. The three animals died six minutes later.

3. A dose of 0.14 milligram of coriamyrtin in aqueous solution given by subcutaneous injection to a guinea pig weighing 170 grams produced the same symptoms as described, but the animal recovered from the effect of the drug two hours after.

SUMMARY

Coriaria intermedia Matsumura is a shrub that occurs in the Mountain Province of the Philippines.

A chemical study of this plant indicates that it contains the poisonous constituent coriamyrtin.

Computed on a moisture-free basis, the amounts of coriamyrtin found in the fruits, leaves, and stems were 0.176, 0.069, and 0.041 per cent, respectively.

Coriamyrtin crystallizes in monoclinic prisms. These crystals are soluble in ether and alcohol but are sparingly soluble in water.

Coriamyrtin melts at 218° C., has an optical rotation of + 42.68°, and appears to have the molecular formula $C_{15}H_{18}O_5$.

Coriamyrtin (after acid hydrolysis) reduces Fehling's solution slightly; but apparently it is not a glucoside, for it does not produce a characteristic osazone and is not hydrolyzed by emulsin.

The toxic effect of coriamyrtin was shown by injecting guinea pigs subcutaneously with an aqueous solution containing varying amounts of the substance. Clonic convulsions were the usual symptom observed.

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ILLUSTRATIONS

PLATE 1

FIG. 1. Clusters of radiating, prismatic crystals of coriamyrtin crystallized from concentrated ethereal solution.

2. Needlelike crystals of the same substance from diluted ethereal solution.

PLATE 2

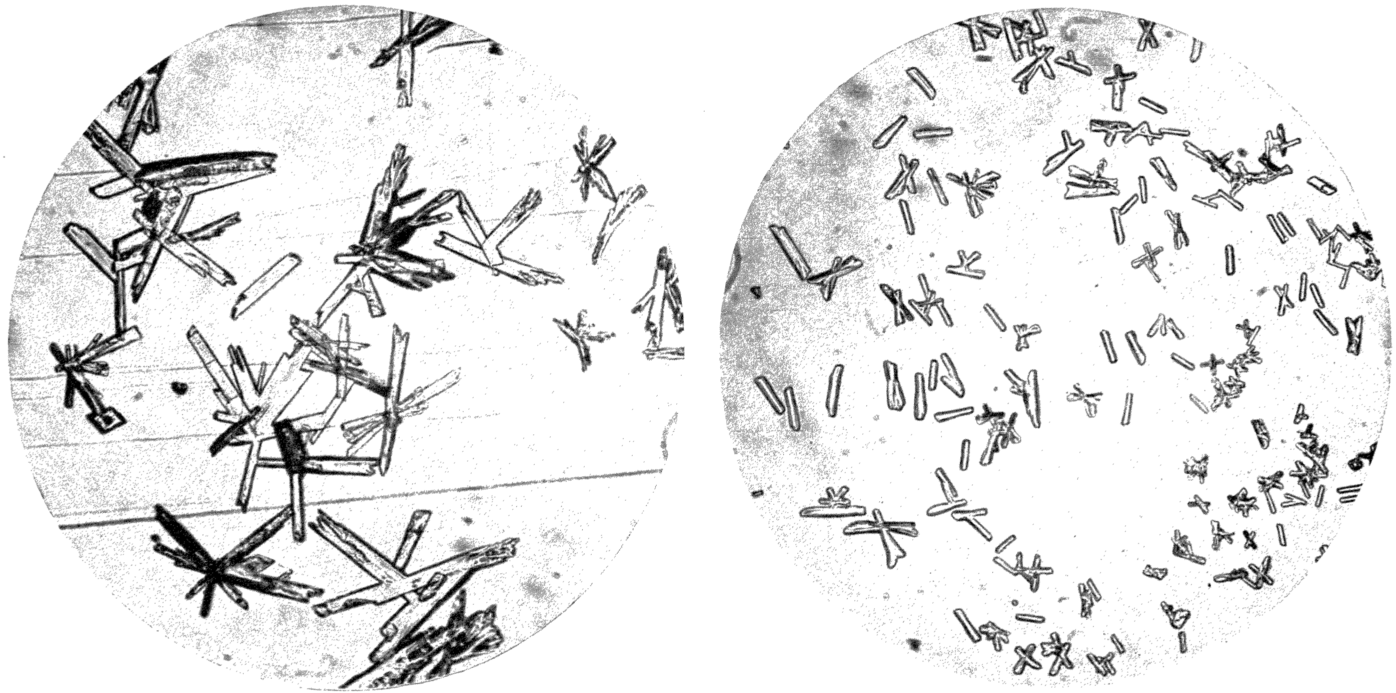
FIG. 3. Prismatic crystals of coriamyrtin which separated from ethyl alcohol.

4. The same substance occurring as aggregates of fine monoclinic prisms in dentritic form when crystallized from methyl alcohol.

PLATE 3

FIG. 5. Monoclinic prismatic crystals of coriamyrtin from diluted aqueous solution.

6. Acicular monoclinic crystals of the same substance from concentrated aqueous solution.



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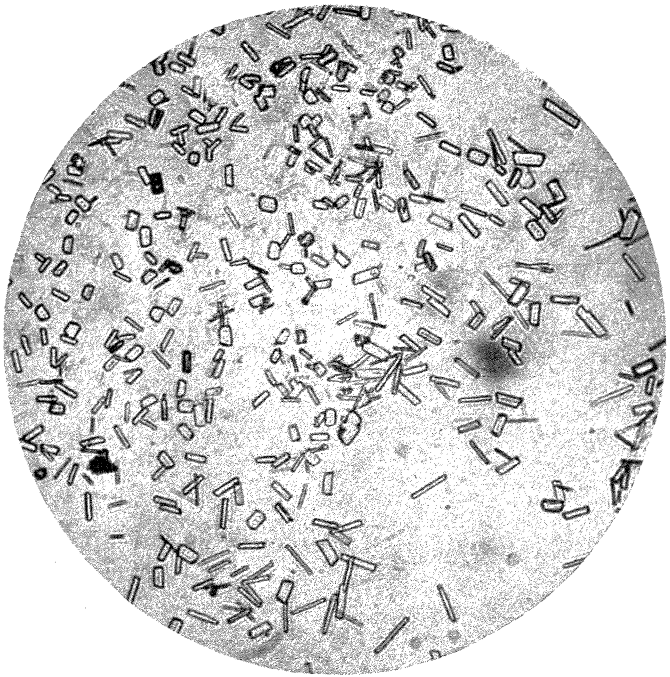

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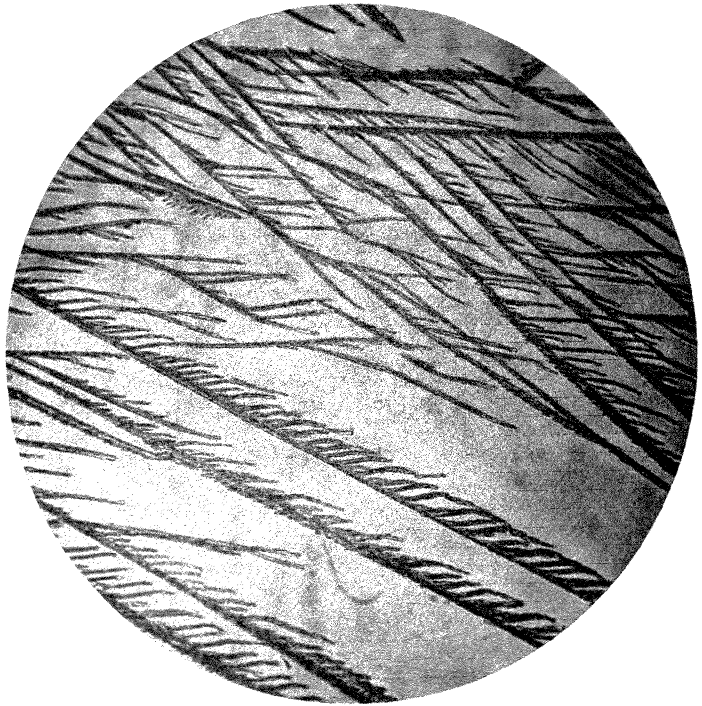

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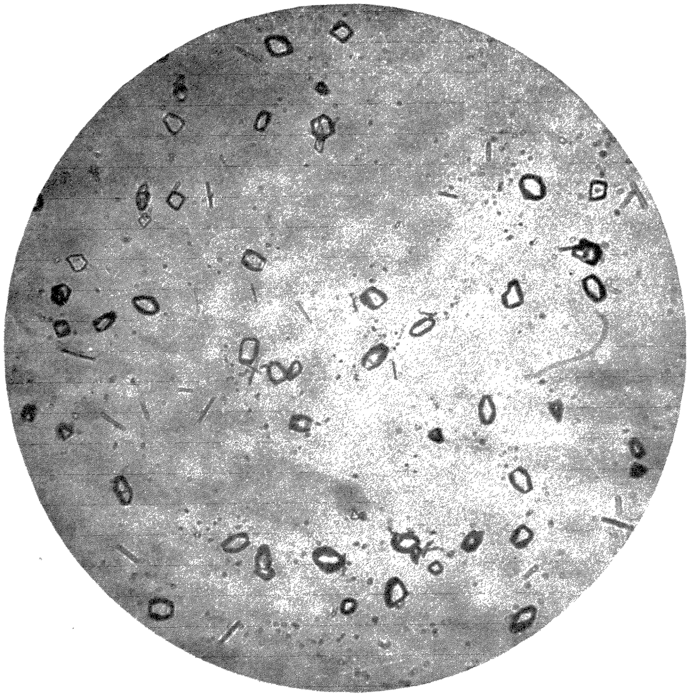
PLATE 2.



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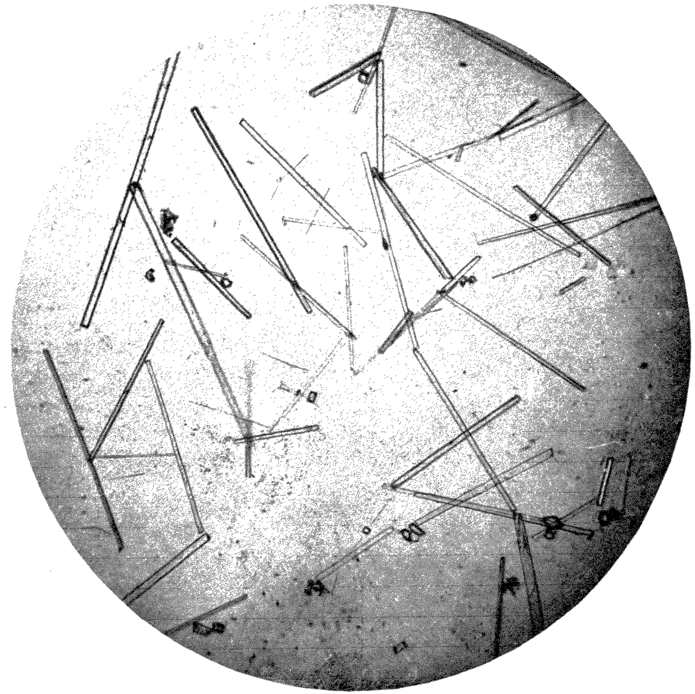

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PLATE 3.

TREMATODE PARASITES OF PHILIPPINE VERTEBRATES, V

FLUKES FROM BIRDS

By MARCOS A. TUBANGUI

Of the Division of Biology, Bureau of Science, Manila

ELEVEN PLATES AND FIVE TEXT FIGURES

Some of the flukes described below were collected several years ago in the neighborhood of Laguna de Bay while the writer was still with the University of the Philippines at Los Baños, Laguna. The others were obtained from birds skinned for mounting purposes and made available for dissection through the courtesy of Mr. R. C. McGregor and his assistants in the section of ornithology, Bureau of Science. The writer is much indebted to these gentlemen and wishes here to express his thanks.

In this paper are reported for the first time from the Philippines representatives of the interesting groups of trematodes commonly known as monostomes (families Cyclocoelidæ and Notocotylidæ) and holostomes (family Strigeidæ). The fact that domestic ducks in the Philippines are infested with several species of flukes, some of which are identical with those of domestic ducks and other birds in Europe and elsewhere, is also worth while noting.

MONOSTOMES

CYCLOCOELIUM (POSTPHARYNGEUM) ORIENTALE var. EURHINUS var. nov. Plate 1, fig. 1.

Numerous specimens of this fluke were collected from the cervical air sac of *Totanus eurhinus* caught in Obando, Bulacan. It is referred to the subgenus *Postpharyngeum* Witenberg, 1926, of the genus *Cyclocoelium* Brandes, 1892, because of the shape of its body, the subterminal position of the mouth opening, the small size of the pharynx, and the moderate development of the vitelline glands. Compared with the already known members of the subgenus, it appears to be most closely related to *C. leidyi* Harrah, 1922, and to *C. orientale* Skrjabin, 1913. It may be distinguished from the former by its longer œsophagus and by

its larger eggs and testes, which are more widely separated from each other. It differs from the latter, a parasite of two species of *Totanus* in Russian Turkestan, only in the size of the eggs and in the contour of the inner walls of the intestinal cæca, which characters are considered not sufficient to separate the two forms into two distinct species.

Description.—Body large, attenuated anteriorly, rounded posteriorly, 14.20 to 21.20 millimeters in length by 2.90 to 4.30 millimeters in maximum breadth behind middle of body length. Cuticle unarmed. Mouth opening subterminal, leads through funnel-shaped passage to globular pharynx 0.26 to 0.29 millimeter in transverse diameter; œsophagus S-shaped, 0.30 to 0.70 millimeter long; intestinal cæca wide in diameter, slightly wavy in outline, with smooth inner walls, and often filled with yellowish food material; they run parallel and close to lateral margins of body, uniting at the posterior end to form an arch.

Testes globular or very slightly compressed, intercæcal, one behind the other, being separated by a distance of 1.40 to 2.85 millimeters; they are normally located to one side of the median line, but sometimes the second testis is almost median in position, being immediately in front of intestinal arch; they are unequal in size, the anterior testis measuring 0.56 to 0.92 millimeter and the posterior testis 0.80 to 1.10 millimeters in transverse diameter. Cirrus sac elongate, thin walled, 0.70 to 0.80 by 0.15 to 0.20 millimeter in size, to one side of median line, usually lateral to œsophagus and corresponding intestinal cæcum; incloses small vesicula seminalis, protrusible cirrus, and poorly developed pars prostatica. Common genital pore median, ventral to pharynx.

Ovary globular, 0.38 to 0.44 millimeter in diameter, intertesticular, to one side of median line opposite testes, forming with latter a sort of triangle. Shell gland compact, almost as large as and behind ovary. Oviduct arises from posterior border of ovary; neither receptaculum seminis nor Laurer's canal apparent, the proximal portion of the uterus being usually swollen and probably serving as seminal receptacle. Uterus with numerous transverse loops, filling up most of space between intestinal cæca anterior to second testis; the coils do not usually extend laterally across inner walls of cæca. Vitellaria in distinct, moderately large follicles, extracæcal, extending from œsophageal bifurcation or slightly behind that level to posterior end of body where the follicles of both sides are separated only

by excretory bladder; transverse vitelline ducts immediately in front of second testis. Eggs (in mounted specimens) oval, operculated, yellowish, 116.5 to 139.3 by 77.0 to 79.0 microns in size; those in distal portion of uterus inclose miracidia with conspicuous eyespots.

Excretory pore median, on dorsal surface near posterior end of body; excretory bladder flattened or somewhat triangular, between intestinal arch and posterior end of body; main lateral excretory vessels given off from each side of bladder, but their anterior course is difficult to trace in preserved specimens.

Variety diagnosis.—*Cyclocoelium* (*Postpharyngeum*) *orientale:* Size 14.20 to 21.20 by 2.90 to 4.30 millimeters. Intestinal cæca slightly wavy in outline but with smooth outer and inner walls. Eggs 116.5 to 139.3 by 77.0 to 79.0 microns in size (in mounted specimens).

Host.—*Totanus eurhinus.*

Location.—Cervical air sac.

Locality.—Obando, Bulacan, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 8.

NOTOCOTYLUS INTESTINALIS sp. nov. Plate 2, figs. 1 and 2.

This parasite may be distinguished from *Notocotylus attenuatus* (Rudolphi, 1809), the type species of the genus, by the shape of its body, which is relatively more elongate; in the anterior extent of its vitellaria, which do not reach beyond the middle of the body length; in the length of the cirrus pouch and of the vagina; and in the number and extent of its transverse uterine coils, which are more numerous and do not pass laterally across the intestinal cæca like those of *N. attenuatus*, as figured by Fuhrmann (1928). It resembles more closely *N. chionis* Baylis, 1928, and *N. tachyeretis* Duthoit, 1931, but differs from them in the measurements of its various organs and in the number of its ventral glands.

Description.—Body small, elongate, 2.30 to 3.25 millimeters in length by 0.54 to 0.75 millimeter in maximum width near posterior end; lateral and posterior margins slightly incurved ventrally. Cuticle of both dorsal and ventral surfaces armed with very minute spines that tend to become sparser toward posterior end. Ventral glands almost uniform in size, evaginable, forty-seven to forty-nine in number, arranged in three longitudinal rows, of which the middle row is more advanced ante-

riorly and consists of fifteen glands and the lateral rows of sixteen to seventeen glands each. Oral sucker globular, 0.12 millimeter in diameter; pharynx absent; œsophagus 0.08 to 0.10 millimeter long; intestinal cæca narrow in diameter, slightly wavy in outline, with few short internal diverticula, and reach to near posterior end of body.

Testes at posterior region of body, symmetrical, extracæcal, elongate, deeply lobed, 0.40 to 0.64 by 0.16 to 0.22 millimeter in size. Cirrus sac long, 0.62 to 0.88 by 0.07 to 0.08 millimeter in size; incloses part of seminal vesicle, pars prostatica, and protrusible cirrus; greater length of seminal vesicle in median line, outside of and behind cirrus sac. Genital pore median, immediately behind œsophageal bifurcation.

Ovary median, intertesticular, distinctly lobed, 0.17 to 0.24 by 0.16 to 0.18 millimeter in size. Shell gland immediately anterior to and smaller than ovary. Oviduct arises from anterior border of ovary; uterus with eighteen to twenty transverse coils, between cirrus sac, intestinal cæca, and shell gland; the coils do not pass laterally across inner cæcal walls. Vagina about three-fourths as long as cirrus pouch. Receptaculum seminis apparently absent; Laurer's canal present. Vitellaria distinctly follicular, extracæcal, extending from behind middle of body length to testes; vitelline reservoir and transverse vitelline ducts dorsal to shell gland. Eggs (in mounted specimens) small, oval, operculated, colorless to pale yellow, with a long filament at each pole, 18.7 to 20.5 by 13.7 to 14.5 microns in size not including filaments.

Main portion of excretory system composed of short bladder that divides into two main lateral branches behind ovary; excretory pore median, on dorsal surface near posterior end of body.

Specific diagnosis.—Notocotylus: Body elongate, 2.30 to 3.25 by 0.54 to 0.75 millimeters in size; lateral and posterior margins slightly incurved ventrally. Cuticle armed with very minute closely set spines. Ventral glands forty-seven to forty-nine in number, arranged in three longitudinal rows: middle row more advanced anteriorly, with fifteen glands and each lateral row with sixteen to seventeen glands. Cirrus sac 0.62 to 0.88 by 0.07 to 0.08 millimeter in size; vagina about three-fourths as long as cirrus sac. Ovary and testes deeply lobed. Vitelline glands do not reach anteriorly beyond middle of body length.

Eggs 18.7 to 20.5 by 13.7 to 14.5 microns in size excluding filaments (in mounted specimens).

Host.—Domestic duck.

Location.—Intestine.

Locality.—Pateros, Rizal, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 65.

NOTOCOTYLUS NAVIFORMIS sp. nov. Plate 1, figs. 2 and 3.

Specimens of this trematode were collected together with *N. intestinalis* from the same host. Because of this fact and its small size, it was thought to represent a growing adult form of the latter. It is separated from *N. intestinalis*, however, in view of its possessing a smaller number of ventral glands and in having its genital pore located in front of the œsophageal bifurcation instead of behind that level, as is the case with the other members of the genus.

Description.—Body elongate, 1.60 to 1.80 millimeters in length by 0.43 to 0.56 millimeter in maximum breadth across or in front of testes; lateral and posterior margins slightly incurved ventrally. Cuticle armed with numerous, very minute spines. Ventral glands evaginable, almost uniform in size, thirty-three in number, arranged in three longitudinal rows, of which the middle row is composed of thirteen glands and each lateral row of ten glands. Oral sucker 0.083 to 0.100 by 0.087 to 0.120 millimeter in size; pharynx absent; œsophagus 0.066 to 0.095 millimeter long; intestinal cæca simple, narrow in diameter, and reach to near posterior end of body.

Testes at posterior region of body, symmetrical, extracæcal, deeply lobed, 0.30 to 0.34 by 0.12 to 0.13 millimeter in size. Cirrus sac 0.36 to 0.40 by 0.035 to 0.040 millimeter in size; incloses terminal portion of long seminal vesicle, pars prostatica, and cirrus; greater length of seminal vesicle in median line, outside of and behind cirrus sac. Genital pore median, midway between oral sucker and œsophageal bifurcation.

Ovary median, between testes, three- to six-lobed, measures 0.12 to 0.14 by 0.10 to 0.12 millimeter. Shell gland smaller than and immediately in front of ovary. Oviduct arises from anterior border of ovary; uterus with fifteen to eighteen transverse coils, between cirrus sac, intestinal cæca, and shell gland; vagina about four-fifths as long as cirrus sac. Receptaculum seminis absent, Laurer's canal present. Vitellaria follicular,

extracæcal, extending from behind middle of body length to testes; vitelline reservoir and transverse vitelline ducts dorsal to shell gland. Eggs (in mounted specimens) colorless to pale yellow, operculated, with long filaments at each pole, 17.8 to 20.8 by 12.5 microns in size, excluding filaments.

Excretory bladder short, divides into two main lateral branches behind ovary and opens outside through excretory pore on dorsal surface near posterior end of body.

Specific diagnosis.—Notocotylus: Body elongate, 1.60 to 1.80 by 0.43 to 0.56 millimeters in size, its lateral and posterior margins slightly incurved ventrally. Cuticle armed with very minute spines. Ventral glands thirty-three in number, arranged in three longitudinal rows, the middle row with thirteen and each lateral row with ten glands. Vagina about four-fifths as long as cirrus sac, which measures 0.36 to 0.40 by 0.035 to 0.040 millimeter. Ovary and testes distinctly lobed. Genital pore median, midway between oral sucker and œsophageal bifurcation. Eggs 17.8 to 20.8 by 12.5 microns in size, excluding filaments (in mounted specimens).

Host.—Domestic duck.

Location.—Intestine.

Locality.—Pateros, Rizal, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 66.

DISTOMES

PHILOPHTHALMUS PROBLEMATICUS sp. nov. Plate 3, fig. 1.

Two adult specimens of this fluke were collected by Dr. Estefano C. Farinas, of the Philippine Bureau of Animal Industry, from the right conjunctival sac of a Rhode Island Red hen in Paco, Manila. The bird was imported from the United States less than a year ago, and it could not be determined where she picked up the parasite.

Of the two specimens collected, only one is available for study, the other having been lost. Comparing this one specimen after it had been stained and mounted in balsam with the other members of the genus *Philophthalmus*, especially with *P. gralli* of chickens as described by Mathis and Leger (1910) from Tonkin and by Sugimoto (1928) from Formosa, it is seen to present several distinguishing features, the most prominent of which are the length and position of its cirrus sac, the shape and position of the testes, and the size of the eggs. According to Mathis and Leger, the testes of *P. gralli* are ovoid, one imme-

diately behind the other, slightly compressed at their opposed surfaces; the anterior testis, in a specimen measuring 6.0 by 1.736 millimeters, is 0.706 by 0.620 millimeter in size and the posterior testis 0.768 by 0.550 millimeter; the cirrus sac (dimensions not given) is located a little behind and lateral to the acetabulum; the eggs vary in size, those in the first half of the uterus measuring 85 by 39 microns, those in the second half of the uterus 120 by 54 microns, and the freshly laid ones 158 by 70 microns. According to Sugimoto, these structures are as follows: The testes are globular, one immediately behind the other, in a straight line or somewhat obliquely placed, mutually compressed, the anterior testis measuring 0.357 to 0.510 by 0.459 to 0.527 millimeter and the posterior testis 0.391 to 0.459 by 0.544 to 0.612 millimeter; the cirrus sac is 0.918 to 1.108 millimeters long and extends posteriorly much beyond the acetabulum; the eggs are 93.6 to 97.5 by 46.8 to 50.0 microns in size. In the Philippine specimen the testes are much smaller than those of either the Tonkin or Formosan forms, the anterior testis measuring 0.20 by 0.44, the posterior 0.26 by 0.44 millimeter; the cirrus sac is shorter, 0.78 by 0.13 millimeter in size and extends posteriorly just beyond the equator of the acetabulum; the eggs are smaller, those at the terminal portion of the uterus measuring 74.8 to 83.2 by 35.2 to 39.5 microns. In view of these and other minor differences, as set forth in Table 1, the conclusion is that the Philippine specimen represents a distinct species.

Description.—Body attenuated anteriorly, broadly rounded posteriorly, measuring 4.48 millimeters in length by 1.62 millimeters in maximum width behind equator of body. Cuticle unarmed. Suckers well developed; oral sucker subterminal, 0.40 by 0.50 millimeter in size; acetabulum 0.57 by 0.53 millimeter, between anterior and middle thirds of body length. Oral sucker followed immediately by pharynx, 0.38 by 0.46 millimeter in size; œsophagus 0.10 millimeter long; intestinal cæca simple, reaching to near posterior end of body.

Testes postovarial, somewhat semicircular in outline, in posterior fourth of body length, one immediately and slightly obliquely behind the other, reciprocally compressed at point of contact; anterior testis measures 0.20 by 0.44, posterior testis 0.26 by 0.44 millimeter. Cirrus sac 0.78 by 0.13 millimeter in size, dorsal to and on the right side of acetabulum, extending posteriorly just beyond the level of equator of this organ; it incloses a prominent seminal vesicle, cirrus, and poorly developed pars

TABLE 1.—*Species of Philophthalmus.*

Species.	Author and date.	Total size.	Size of oral sucker.	Size of pharynx.	Size of acetabulum.	Length of cirrus sac.
		mm.	*mm.*	*mm.*	*mm.*	*mm.*
P. palpebrarum, Looss, 1899	Looss, 1899	4.0×1.0	[a]0.45	[a]0.45	[a]0.6	Very long; reaches to behind acetabulum.
P. lucipetus (Rud., 1819)	Braun, 1902	7.0×1.7	0.33×0.40	0.295×0.317	0.80×0.93	Long; reaches to immediately behind acetabulum.
P. lacrymosus (Braun, 1897)	Braun, 1902	3.5–4.5 ×1.2–1.7	0.335×0.477	0.600×0.399	0.611×0.733	
P. nocturnus Looss, 1907	Looss, 1907	5.0–7.0 ×1.5–2.5	[a]0.43–0.52	0.45×0.35	[a]0.65–0.70	1.6
P. gralli Mathis and Leger, 1910	Mathis and Leger, 1910	3.0–6.0 ×0.9–1.7	0.285×0.396	----------	[a]0.588	Long; reaches to a little behind acetabulum.
P. gralli Mathis and Leger, 1910	Sugimoto, 1928	4.25–5.27 ×1.36–1.53	0.374–0.408 ×0.289–0.357	0.289–0.34 ×0.221–0.289	0.561–0.765 ×0.510–0.765	0.918–1.108
P. anatinus Sugimoto, 1928	Sugimoto, 1928	3.56–6.51 ×0.84–1.05	0.39–0.51 ×0.36–0.37	0.29–0.34 ×0.27–0.49	[a]0.47–0.54	0.867–1.7; reaches to far behind acetabulum.
P. problematicus sp. nov.	Tubangui, the present paper.	4.48×1.62	0.4×0.5	0.38×0.46	0.57×0.53	0.78; extends to equator of acetabulum.
P. rizalensis sp. nov.	do	1.73–3.08 ×0.56–0.97	0.175–0.240 ×0.20–0.28	0.18–0.26 ×0.16–0.24	0.28–0.44 ×0.32–0.42	0.54–0.84; reaches to behind acetabulum.

Species.	Author and date.	Shape and size of testes.	Shape and size of ovary.	Vitellaria.	Size of eggs in microns.	Host and locality.
		mm.	*mm.*			
P. palpebrarum, Looss, 1899	Looss, 1899		Rounded	Tubular	54×31; miracidia without eyespot.	*Corvus cornix*; Egypt.
P. lucipetus (Rud., 1819)	Braun, 1902	Testes unequal; anterior 5-lobed; posterior less clearly lobed.	Rounded, slightly compressed 0.214 across.	Follicular	83–104×31–36, miracidia with eyespots.	*Larus fuscus*, *L. glaucus*, Europe.
P. lacrymosus (Braun, 1897)	Braun, 1902		0.323 across		67×23.4; miracidia with eyespots.	*Larus maculipennis*; Brazil.
P. nocturnus Looss, 1907	Looss, 1907	Distinctly lobed	Rounded	Tubular	100×40–50; miracidia with eyespots.	*Athene noctua*; Egypt.
P. gralli Mathis and Leger, 1910.	Mathis and Leger, 1910.	Ovoid; anterior 0.706×0.620; posterior 0.768×0.550.	Rounded, 0.248 across.	do	158×70; miracidia with eyespots.	Domestic chicken; Tonkin.
P. gralli Mathis and Leger, 1910.	Sugimoto, 1928	Globular; anterior 0.357–0.51×0.459–0.527; posterior 0.391–0.459×0.544–0.612.	0.238×0.357	do	93.6–97.5×46.8–50; miracidia with eyespots.	Domestic chicken; Formosa.
P. anatinus Sugimoto, 1928	Sugimoto, 1928	Globular, anterior 0.3–0.5×0.22–0.47; posterior 0.3–0.4×0.25–0.45.	Spherical; 0.22 across.	do	109–117×58–62; miracidia with eyespots.	Domestic duck; Formosa.
P. problematicus sp. nov.	Tubangui, the present paper.	Compressed; anterior 0.20×0.44; posterior 0.26×0.44.	Slightly compressed, 0.28×0.34.	do	74.8–83.2×35.3–39.5; miracidia with eyespots.	Domestic chicken; Philippines.
P. rizalensis sp. nov.	do	Spherical to compressed, almost equal in size; 0.16–0.28×0.20–0.36	Compressed; 0.10–0.12×0.13–0.20	do	106–112×50–54; miracidia with eyespots.	Domestic duck; Philippines.

[a] Transverse diameter.

prostatica. Common genital pore median, ventral to œsophageal bifurcation.

Ovary near median line, proximate to anterior testis, slightly compressed, with smooth surface, 0.28 by 0.34 millimeter in size. Oviduct arises from posterolateral border of ovary; shell gland lateral to anterior testis; receptaculum seminis and Laurer's canal not evident. Uterus well developed, occupying most of space between acetabulum and testes and extending to lateral margins of body across vitelline glands and intestinal cæca. Vagina about twice as long as cirrus pouch. Vitellaria tubular, extracæcal; they extend from a short distance (about 0.45 millimeter) behind posterior level of acetabulum to first testis, at which level the glands of both sides turn mesially and meet behind ovary. Eggs of characteristic asymmetrical shape, with one pole more pointed than the opposite pole, yellowish, those in distal portion of uterus measuring 74.5 to 83.2 by 35.3 to 39.5 microns; they inclose fully developed miracidia that are each provided with a pigmented eyespot visible near the wider pole of the eggshell.

Excretory pore posteroterminal; excretory bladder Y-shaped, the main stem dividing into two branches behind second testis.

Specific diagnosis.—*Philophthalmus:* Body 4.48 by 1.62 millimeters in size, anterior end attenuated, posterior end broadly rounded. Cuticle unarmed. Oral sucker 0.40 by 0.50 millimeter in size; acetabulum 0.57 by 0.53 millimeter, between anterior and middle thirds of body length; pharynx almost as large as oral sucker, œsophagus 0.10 millimeter long. Cirrus sac 0.78 by 0.13 millimeter in size, extending posteriorly just beyond level of equator of acetabulum. Uterus well developed extending to lateral margins of body across vitelline glands and intestinal cæca. Vitellaria tubular, reaching anteriorly beyond middle of distance between acetabulum and ovary. Ovary 0.28 by 0.34 millimeter in size, close to anterior testis. Testes semicircular, one obliquely and immediately behind the other. Mature eggs (in mounted specimen) 74.8 to 83.2 by 35.3 to 39.5 microns in size, inclosing fully developed miracidia provided with eyespots.

Host.—Domestic chicken (*Gallus gallus domesticus*).

Location.—Conjunctival sac.

Locality.—? Manila, Philippine Islands.

Type specimen.—Philippine Bureau of Science parasitological collection, No. 67.

PHILOPHTHALMUS RIZALENSIS sp. nov. Plate 3, fig. 2.

As shown in Table 1, this parasite of the Philippine domestic duck is smaller than the other members of the genus *Philophthalmus*. The dimensions of its different organs are also much smaller, but its eggs compare favorably in size with the larger eggs of *P. lucipetus*, *P. nocturnus*, *P. gralli*, and *P. anatinus*. It is similar to *P. palpebrarum*, *P. nocturnus*, *P. anatinus*, and *P. gralli* in the position of its cirrus pouch, which extends posteriorly much beyond the acetabulum, while in the extent of its vitelline glands that do not reach anteriorly beyond the middle of the distance between the acetabulum and the ovary, it is related to *P. lacrymosus* and *P. lucipetus*.

Description.—Body small, anterior end narrower than posterior end, 1.73 to 3.08 millimeters in length by 0.56 to 0.97 millimeter in maximum width behind equator of body. Cuticle smooth. Suckers well developed; oral sucker subterminal, 0.175 to 0.240 by 0.200 to 0.280 millimeter in size; acetabulum between anterior and middle thirds of body length, measuring 0.28 to 0.44 by 0.32 to 0.42 millimeter. Mouth opening ventroterminal; prepharynx absent; pharynx almost as large as oral sucker, 0.18 to 0.26 by 0.16 to 0.24 millimeter in size; œsophagus 0.04 to 0.07 millimeter in length; intestinal cæca simple, narrow in diameter, reaching to near posterior end of body, one cæcum often shorter than its fellow.

Testes roundish to oval in outline, one immediately and obliquely behind the other, at posterior fourth of body length, their opposed surfaces being flattened; they measure 0.16 to 0.28 by 0.20 to 0.36 millimeter; surface of anterior testis smooth, except at posterior border where there may be a slight notch; surface of posterior testis may also be smooth, but more frequently it is notched in two places so that the organ appears 3-lobed. Cirrus sac slender, only slightly dilated at posterior end, 0.54 to 0.84 by 0.04 to 0.08 millimeter in size, and extends posteriorly much beyond level of acetabulum; incloses prominent seminal vesicle, cirrus, and pars prostatica. Common genital opening median, immediately behind pharynx or ventral to œsophageal bifurcation.

Ovary near median line, pretesticular, transversely oval, 0.10 to 0.12 by 0.13 to 0.20 millimeter in size. Oviduct arises from posterior border of ovary; shell gland compact, to one side of median line, behind ovary; neither receptaculum seminis nor Laurer's canal appears to be present. Uterus moderately de-

veloped, between testes and cirrus pouch; laterally it passes across intestinal cæca, but not beyond vitelline glands. Vagina prominent, slightly coiled, about one and one-half times as long as cirrus sac. Vitellaria tubular, but at times they have the appearance of being acinous or follicular due to dilatation of the walls of the tubes at regular intervals with yolk material; extend from anterior testis to middle of distance between acetabulum and ovary. Mature eggs in distal portion of uterus, yellowish, asymmetrical, one pole more pointed than the opposite pole, each inclosing a well-developed miracidium provided with a pigmented eyespot; in mounted specimens they measure 83.2 to 109.3 by 37.4 to 52.0 microns, in the fresh state 106 to 112 by 50 to 54 microns.

Excretory bladder Y-shaped; main stem short but roomy, divides into two main lateral branches behind second testis. Excretory pore posteroterminal.

Specific diagnosis.—Philophthalmus: Body small, measuring 1.73 to 3.08 by 0.56 to 0.97 millimeters. Cuticle unarmed. Oral sucker 0.175 to 0.240 by 0.200 to 0.280 millimeter in size; acetabulum 0.28 to 0.44 by 0.32 to 0.42 millimeter, between anterior and middle thirds of body length; pharynx 0.18 to 0.26 by 0.16 to 0.24 millimeter; œsophagus 0.04 to 0.07 millimeter long. Cirrus sac slender, 0.54 to 0.84 by 0.04 to 0.08 millimeter in size, extends posteriorly much beyond acetabulum. Testes roundish to oval, one immediately and obliquely behind its fellow, the posterior testis often 3-lobed. Vitellaria tubular, not reaching anteriorly beyond middle of distance between ovary and acetabulum. Mature eggs inclose miracidia with pigmented eyespots and measure 106 to 112 by 50 to 54 microns (freshly laid).

Host.—Domestic duck.

Location.—Conjunctival sac.

Locality.—Pateros, Rizal, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 80.

LEUCOCHLORIDIUM HYPOTÆNIDIARUM sp. nov. Plate 4, figs. 1 and 2.

This constitutes the second species of *Leucochloridium* to be described from the Philippines, the first species being *L. dasylophi* Tubangui, 1928, a parasite of the rough-crested cuckoo, *Dasylophus superciliosus*. The two forms differ from each other in many respects, but especially in the character of the cuticle

and in the posterior extent of the vitelline glands. The cuticle of *L. dasylophi* is armed with delicate spines and its vitelline glands extend only as far as the level of the ovary; the cuticle of *L. hypotænidiarum*, on the other hand, is unarmed and its vitelline glands reach posteriorly much beyond the level of the posterior testis, almost as far as the blind ends of the intestinal cæca. Compared further with the other species of the genus, as summarized by McIntosh (1927), the present form is found to agree with *L. soræ* in the extent of its vitellaria, in the arrangement of the ovary and testes, and in the position of the acetabulum and of the genital pore. It differs from *L. soræ,* however, in having a less-elongated body, a larger cirrus pouch, better-developed vitelline follicles, and testes that are almost similar in size.

Description.—Body oval to elongate, 1.95 to 3.46 millimeters in length by 0.97 to 1.56 millimeters in maximum breadth across or immediately behind acetabulum. Cuticle unarmed. Oral sucker rounded or slightly oval transversely, ventroterminal, 0.48 to 0.62 by 0.60 to 0.70 millimeter in size. Acetabulum more or less rounded, at, or more frequently slightly anterior to, middle of body length, 0.60 to 0.72 by 0.54 to 0.76 millimeter in size. Mouth large, leads through narrow passage to oval pharynx measuring 0.16 to 0.18 by 0.20 to 0.24 millimeter; œsophagus absent; intestinal cæca simple, arched on each side of pharynx, and reach to near posterior end of body, where they are often more dilated in diameter.

Testes small, transversely oval, with smooth margins, one obliquely behind the other, intercæcal, about midway between acetabulum and posterior end of body; anterior testis measures 0.13 to 0.15 by 0.24 to 0.28, posterior testis 0.14 to 0.18 by 0.20 to 0.27 millimeter. Cirrus sac at posterior region of body, median, thick walled, oval, 0.20 to 0.34 by 0.12 to 0.18 millimeter in size; incloses pars prostatica and protrusible cirrus; seminal vesicle poorly developed, outside and in front of cirrus sac. Genital pore median, dorsal, near posterior end of body.

Ovary oval, to one side of median line, in front of and very proximate to posterior testis, 0.16 to 0.22 by 0.20 to 0.30 millimeter in size. Oviduct arises from mesial border of ovary; shell gland median, smaller than ovary, located in wedge-shaped area between ovary and second testis; Laurer's canal directed posteriorly from oötype complex; receptaculum seminis not ap-

parent. Uterus very profuse, occupying most of intercæcal space not otherwise occupied by other structures; it is limited anteriorly by intestinal branches, although in rare cases a few uterine loops extend beyond the cæcal arches; posteriorly it crowds out the genital glands. In some of the large specimens examined (Plate 4, fig. 2), the uterine loops are so crowded together that it is impossible to make out their arrangement; in other cases, especially in smaller specimens (Plate 4, fig. 1), the uterus is seen to be composed of short, ascending and descending transverse loops, located on opposite sides of the median line and separated by a short longitudinal space in the acetabular region. Vagina short, leads to genital opening beside cirrus sac. Vitellaria follicular, well developed, mostly extracæcal, extending from level of pharynx or slightly beyond to almost as far as the blind terminals of the intestinal cæca; transverse vitelline ducts at level of second testis; vitelline reservoir median, immediately behind shell gland. Mature eggs (in mounted specimens) oval, operculated, yellowish brown, 22.5 to 25.0 by 14.5 to 16.5 microns in size.

Excretory pore dorsal, in front of genital opening.

Specific diagnosis.—*Leucochloridium:* Body oval to elongate, 1.95 to 3.46 by 0.97 to 1.56 millimeters in size. Cuticle unarmed. Acetabulum at or a little anterior to equator of body, larger than oral sucker. Reproductive glands near together, about midway between acetabulum and posterior end of body, the ovary in front of second testis on one side of median line and first testis on opposite side. Cirrus sac oval, 0.20 to 0.34 by 0.12 to 0.18 millimeter. Genital pore median, dorsal, near posterior end of body. Vitellaria well developed, mostly extracæcal, from level of pharynx or slightly beyond to almost the blind terminals of intestinal cæca. Eggs 22.5 to 25.0 by 14.5 to 16.5 microns in size (in mounted specimens).

Hosts.—*Hypotænidia striata* (type host) and *Turnix fasciata.*

Location.—Intestine.

Locality.—Novaliches, Rizal, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 68.

GLAPHYROSTOMUM RALLINARUM sp. nov. Plate 5, fig. 1.

The systematic position of this trematode in the subfamily Harmostominæ Braun, 1900, as defined by Witenberg (1925), is somewhat doubtful. Taking into consideration the characters

used in the subdivision of the subfamily into genera, it is found that the parasite agrees with members of the genera *Harmostomum, Glaphyrostomum,* and *Urotocus* in the shape of its body; with those of *Urotocus* and *Leucochloridium* in the posterior extent of its vitelline glands; with those of *Ithyogonimus* and *Scaphyostomum* in the anterior extent of its uterus; and with those of *Ithyogonimus* and *Glaphyrostomum* in the position of its genital pore. On the other hand, it differs from members of *Harmostomum* in the position of its genital pore, the posterior extent of its vitellaria, and the anterior limit of its uterus; from those of *Urotocus* and *Leucochloridium* in the position of its genital pore; and from those of *Ithyogonimus* and *Scaphyostomum* in the shape of its body and the posterior extent of its vitelline glands. It seems to fit most closely in *Glaphyrostomum* Braun, 1901, differing from members of this genus only in the extent of its vitellaria and uterine coils, which characters may be considered of specific rather than of generic importance. The writer agrees with Werby (1928) that there is need of revising this group of trematodes.

Description.—Body elongate, tongue-shaped, 4.92 millimeters in length by 1.46 millimeters in maximum breadth across or in front of first testis (measurements based on three specimens of a uniform size). Cuticle smooth. Oral sucker ventroterminal, cup-shaped, 0.62 by 0.66 millimeter in size; acetabulum circular, 0.80 to 0.90 millimeter in diameter, between anterior and middle thirds of body length. Mouth opening wide, ventroterminal; pharynx oval, 0.22 to 0.24 by 0.21 to 0.22 millimeter in size; œsophagus absent; intestinal cæca arched on each side of pharynx, narrow in diameter, slightly wavy in their course, and extend to near posterior end of body.

Reproductive glands close together at posterior region of body. Testes distinctly lobed, one almost immediately or slightly obliquely behind the other, separated by a space less than one-half of the diameter of either one of them; anterior testis four- to five-lobed, 0.42 to 0.50 by 0.50 millimeter in size; posterior testis three- to four-lobed, 0.28 to 0.46 by 0.47 to 0.52 millimeter. Cirrus pouch elongate, slightly bent, strongly muscular, 0.45 to 0.50 by 0.10 to 0.12 millimeter in size, its bulk between anterior testis and ovary; incloses long protrusible cirrus. Seminal vesicle long, coiled, outside of cirrus sac. Genital pore ventral, median, at intertesticular level.

Ovary intertesticular, to one side of median line opposite anterior testis, divided transversely into anterior and posterior lobes, each of which may be again divided indistinctly into minor lobes; it measures 0.34 to 0.36 by 0.26 to 0.30 millimeter. Shell gland median, smaller than ovary, beside the latter and in front of posterior testis; Laurer's canal long, narrow, directed posteriorly from oötype complex; receptaculum seminis absent. Uterus confined within intercæcal space, extending anteriorly up to acetabulum and posteriorly up to ovary and first testis; it has probably two series of short transverse coils like the majority of Harmostominæ, but the coils are so crowded together that they cannot be distinguished. Vitellaria follicular, extracæcal, extending from posterior level of acetabulum to level of ovary; transverse vitelline ducts and vitelline reservoir in front of posterior testis. Eggs (in mounted specimens) numerous, operculated, yellowish brown, 22.0 to 25.0 by 13.7 to 14.5 microns in size.

Excretory pore dorsal, near posterior end of body, immediately behind level of posterior testis.

Specific diagnosis.—Glaphyrostomum: Body elongate, 4.92 to 1.46 millimeters in size. Cuticle smooth. Ovary and testes distinctly lobed, the former on one side of median line, opposite latter. Anterior extent of uterus up to acetabulum. Vitellaria from posterior level of acetabulum to level of ovary. Eggs (in mounted specimens) 22.0 to 25.0 by 13.7 to 14.5 microns in size.

Host.—Rallina eurizonoides.

Location.—Intestine.

Locality.—Novaliches, Rizal, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 69.

PSILOCHASMUS LONGICIRRATUS Skrjabin, 1913. Plate 5, fig. 2.

Four out of ten domestic ducks brought from Pateros, Rizal, were found lightly infested with an interesting trematode belonging to the genus *Psilochasmus* Lühe, 1909, emend. Odhner, 1913. The specimens collected differ from *P. oxyurus* (Creplin, 1825), the type species of the genus, in the length of the cirrus pouch and in the anterior extent of the vitelline glands. They also differ from *P. agilis* Travassos, 1925, in the anterior extent of the vitellaria, in the posterior extent of the cirrus pouch and in the size of the testes; and from *P. lecithosus* Otte, 1926, of the domestic duck in Germany in being smaller and in possess-

ing lobed testes. They resemble *P. longicirratus* Skrjabin, 1913, a parasite of *Fuligula nyroka* in Russian Turkestan, most closely and are probably identical with it.

Description.—Body small, elongate, attenuated at both ends, the posterior extremity narrowing abruptly into a protrusible and retractile tail-like process (this region of the body is well supplied with circular muscle fibers); length 3.30 to 4.32 millimeters, maximum width 0.65 to 1.13 millimeters, behind middle of body length. Cuticle unarmed. Oral sucker subterminal, 0.24 to 0.28 by 0.22 to 0.28 millimeter in size. Acetabulum between anterior and middle thirds of body length, bulges prominently from ventral surface, is provided with a sphincter, and measures 0.46 to 0.50 by 0.40 to 0.50 millimeter. Mouth subterminal, separated from pharynx by short prepharynx 0.016 to 0.066 millimeter long; pharynx 0.16 to 0.20 by 0.17 to 0.18 millimeter in size; œsophagus 0.20 to 0.60 millimeter long; intestinal cæca simple, narrow in diameter, extending posteriorly just in front of posterior level of vitelline glands.

Testes postequatorial, postovarial, tandem, close together, oval, either smooth or slightly lobed; anterior testis measures 0.37 to 0.46 by 0.25 to 0.38 millimeter, posterior testis 0.39 to 0.48 by 0.23 to 0.34 millimeter. Cirrus sac very elongate, slightly enlarged posteriorly, 1.00 to 1.30 by 0.10 to 0.16 millimeters in size and extends from genital pore to posterior level of ovary; incloses a prominent seminal vesicle and protrusible cirrus. Common genital pore preacetabular, usually to left side of median line.

Ovary spherical, median, immediately postequatorial, 0.12 to 0.16 millimeter in diameter. Shell gland between ovary and anterior testis; receptaculum seminis absent, Laurer's canal present. Uterus relatively short, with few coils, between anterior testis, intestinal cæca, and acetabulum. Vitellaria distinctly follicular, mostly extracæcal, extending from immediately behind posterior level of acetabulum to behind second testis where the follicles of the two sides unite. Eggs usually few, oval, yellowish, operculated, thin shelled, averaging in mounted specimens 91.5 by 58.2 microns in size.

Excretory system conforms in principle to description by Odhner (1913) of the excretory system of members of the genus *Psilochasmus*. A subcutaneous network of small vessels, which are especially prominent in the anterior portion of the body, is

present. An excretory sinus dorsal to the acetabulum is not visible in the specimens studied, but a median, narrow duct is present behind the second testis and opens outside through an excretory pore located at the tip of the protrusible, posterior, tail-like process.

Host.—Domestic duck.

Location.—Intestine.

Locality.—Pateros, Rizal, Luzon.

ECHINOSTOMA CHLOROPODIS var. PHILIPPINENSIS var. nov. Plate 6, fig. 1, and text fig. 1.

Specimens of this fluke were collected on various occasions from the small intestine of moor hens (*Gallinula chloropus* Linnæus) caught in Laguna de Bay in the vicinity of Los Baños, Laguna. As its proposed name indicates, it bears a very close resemblance to *Echinostoma chloropodis* (Zeder, 1800), reported from the same host in Europe. It differs from the latter, as described by Dietz (1910), only in the number and size of the collar spines and in the size of the eggs and of the various internal organs.

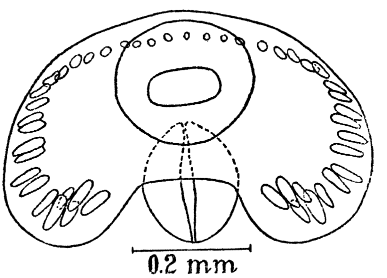

FIG. 1. *Echinostoma chloropodis* var. *philippinensis* var. nov., cephalic collar and spines.

Description.—Body large, elongate, 7.55 to 10.00 by 1.05 to 1.22 millimeters in size, its lateral margins between suckers slightly inrolled ventrally. Cuticle of ventral surface from anterior end to acetabulum armed with spines. Oral sucker subterminal, small, measuring 0.20 to 0.26 by 0.22 to 0.26 millimeter; acetabulum large, cup-shaped, 0.70 to 0.78 millimeter from anterior end of body, 0.89 to 0.93 by 0.80 to 0.83 millimeter in size. Head collar well developed, reniform, 0.40 to 0.50 by 0.60 to 0.73 millimeter in size, armed with forty-six to forty-seven spines arranged in two alternating rows, which may be grouped as follows: four blunt, large, ventral, corner spines on each side, measuring 66.5 to 70.7 by 20.8 to 21.6 microns, and thirty-eight to thirty-nine dorsal and lateral spines that are smaller and measure 33.2 to 62.4 by 12.5 to 16.6 microns (dorsal spines smallest). Prepharynx absent; pharynx 0.21 to 0.24 by 0.16 to 0.19 millimeter in size; œsophagus 0.28 to 0.32 millimeter long, bifurcates immediately behind anterior

border of acetabulum; intestinal cæca narrow in diameter, extend to near posterior end of body.

Reproductive glands in middle of body length. Testes elongate, with slightly indented margins, tandem, median, postovarial, nearly similar in size, measuring 0.58 to 0.71 by 0.26 to 0.31 millimeter. Cirrus sac relatively small, oval, measures 0.24 by 0.17 millimeter, in front of equator of acetabulum, barely protruding anteriorly beyond anterior border of latter; incloses seminal vesicle, cirrus, and pars prostatica. Common genital pore median, immediately preacetabular, in front of œsophageal bifurcation.

Ovary globular, median, 0.31 to 0.38 millimeter in diameter. Oviduct arises from posterior border of ovary; shell gland prominent, as big as or even larger than ovary, between latter and anterior testis; receptaculum seminis absent, Laurer's canal present. Uterus moderately developed, intercæcal, from ovary to acetabulum. Vitellaria follicular, extending from middle of acetabulum or slightly behind that level to near posterior end of body, as far as blind terminals of intestinal cæca; follicles of two sides do not intermingle behind posterior testis; transverse vitelline ducts and vitelline reservoir dorsal to shell gland. Eggs oval, operculated, thin shelled, yellowish, 101 to 104 by 65 to 75 microns in size (in mounted specimens).

Excretory pore median, posteroterminal; excretory bladder Y-shaped, the stem with several side branches and dividing into two main branches behind second testis.

Variety diagnosis.—Echinostoma chloropodis: Head collar with forty-six to forty-seven spines; four ventral corner spines on each side, measuring 66.5 to 70.7 by 20.8 to 21.6 microns; rest of spines, thirty-eight to thirty-nine in number, 33.2 to 62.4 by 12.5 to 16.6 microns in size. Acetabulum 0.70 to 0.78 millimeter from anterior end, 0.89 to 0.93 by 0.80 to 0.83 millimeter in size. Ovary 0.31 to 0.38 millimeter across; testes slightly indented, 0.58 to 0.71 by 0.26 to 0.31 millimeter in size; cirrus sac 0.24 by 0.17 millimeter. Eggs in mounted specimens 101 to 104 by 65 to 75 microns.

Host.—Gallinula chloropus.

Location.—Small intestine.

Locality.—Los Baños, Laguna, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 5.

ECHINOSTOMA BATANGUENSIS sp. nov. Plate 6, fig. 2, and text fig. 2.

Although only one specimen of this fluke is available for description, it is here proposed as a new species. It differs from all known echinostomes, the descriptions of which are available to the writer, in the large number of its collar spines.

Description.—Body elongate, 5.94 by 1.19 millimeters in size; lateral margins between suckers slightly inrolled ventrally. Cuticle of ventral surface up to acetabulum armed with spines. Oral sucker measures 0.25 by 0.24 millimeter; acetabulum 0.68 millimeter from anterior end of body, 1.10 by 0.90 millimeters in size. Head collar reniform, 0.76 millimeter across, armed with seventy-two spines arranged in two alternating rows and measuring 37.5 to 58.2 by 18.7 to 24.9 microns in size, the dorsal spines being the smallest.

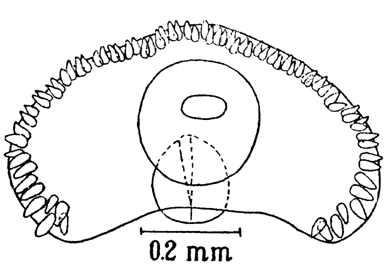

FIG. 2. *Echinostoma batanguensis* sp. nov., cephalic collar and spines.

Pharynx 0.18 by 0.16 millimeter in size; œsophagus 0.18 millimeter long, bifurcates in front of acetabulum; intestinal cæca simple, extending to near posterior end of body.

Testes tandem, small, oval, postovarial, almost similar in size, anterior testis measuring 0.46 by 0.32 and posterior testis 0.44 by 0.30 millimeter. Cirrus sac small, oval, 0.40 by 0.22 millimeter in size, in front of equator of acetabulum, barely extends anteriorly beyond margin of latter. Common genital pore median, between acetabular margin and œsophageal bifurcation.

Ovary compressed, equatorial, 0.22 by 0.34 millimeter in size. Oviduct arises from posterior border of ovary; shell gland as large as ovary, between latter and anterior testis; receptaculum seminis absent, Laurer's canal present. Uterus moderately developed, intercæcal, mostly between ovary and acetabulum. Vitellaria follicular, from posterior level of acetabulum to posterior end of body, beyond blind terminals of intestinal cæca; vitelline follicles of two sides unite behind second testis. Eggs oval, yellowish, operculated, 80.0 to 85.0 by 58.0 to 62.5 microns in size (in mounted specimens).

Excretory pore posteroterminal; excretory bladder long, narrow, with several side branches, and divides into two main branches behind second testis.

Specific diagnosis.—*Echinostoma:* Body elongate, 5.94 by 1.19 millimeters in size. Oral sucker 0.25 by 0.24 millimeter; acetabulum 0.68 millimeter from anterior end, 1.10 by 0.90 millimeters in size. Head collar 0.76 millimeter across, armed with seventy-two spines measuring 37.5 to 58.2 by 18.7 to 24.9 microns. Testes oval, about equal in size; cirrus sac 0.40 by 0.22 millimeter in size. Eggs 80.0 to 85.0 by 58.0 to 62.5 microns (in mounted specimen).

Host.—*Gallinula chloropus.*

Location.—Small intestine.

Locality.—Batangas, Batangas, Luzon.

Type specimen.—Philippine Bureau of Science parasitological collection, No. 4.

ECHINOSTOMA REVOLUTUM (Froelich, 1802) Dietz, 1909. Plate 7, fig. 1, and text fig. 3.

Synonym: Echinostoma echinatum (Zeder, 1803) of several authors.

A single specimen of this trematode was collected from the cæcum of a domestic duck from Pateros, Rizal, Luzon. It agrees in many important respects, especially in the number and grouping of the collar spines, with *Echinostoma revolutum,* as described by Looss (1899), Dietz (1910), and Johnson (1920). It most probably represents a young growing adult of this species, as attested by the length of its uterus which contains only a few coils and eggs.

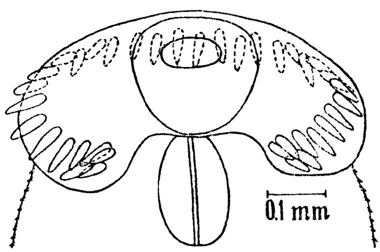

FIG. 3. *Echinostoma revolutum* (Froelich, 1802), cephalic collar and spines.

Description.—Body elongate, 5.83 millimeters in length by 0.97 millimeter in maximum breadth across equator of body; lateral margins between suckers slightly inrolled ventrally. Cuticle of ventral surface from anterior end to level between testes and of dorsal surface from anterior end to acetabulum, armed with spines. Oral sucker measures 0.21 by 0.22 millimeter; acetabulum about 1.0 millimeter from anterior end of body and 0.54 millimeter in diameter. Head collar reniform, 0.60 millimeter across, armed with thirty-seven spines arranged in two alternating rows and grouped as follows: Four corner ventral spines on each side, of which the inner pairs are 52.0 to 60.0 by 16.6 to 17.8 microns in size; the rest of the corner

spines as well as the lateral and dorsal spines are larger and measure 62.5 to 72.8 by 16.6 to 20.8 microns. Pharynx 0.18 by 0.12 millimeter in size; œsophagus 0.42 millimeter long, bifurcates in front of acetabulum; intestinal cæca long, simple, reaching to near posterior end of body.

Testes small, tandem, postovarial, lobed, anterior testis 0.28 by 0.40 millimeter and posterior testis 0.32 by 0.38 millimeter in size. Cirrus sac measures 0.24 by 0.19 millimeter, its greater volume in area between acetabulum and œsophageal bifurcation; incloses coiled seminal vesicle, pars prostatica, and cirrus. Common genital opening median, immediately behind œsophageal bifurcation.

Ovary compressed, immediately postequatorial, 0.16 by 0.27 millimeter in size. Shell gland larger than and behind ovary; receptaculum seminis absent, Laurer's canal present. Uterus short, with few coils and eggs. Vitelline follicles extend from behind level of acetabulum to near posterior end of body, about as far as the blind terminals of the intestinal cæca; follicles of two sides unite behind second testis. Eggs yellowish, oval, operculated, 91.5 to 99.8 by 54.0 to 58.2 microns in size (in mounted specimens).

Excretory bladder long, somewhat dilated posteriorly and divides into two main branches behind second testis; excretory pore posteroterminal.

Host.—Domestic duck.

Location.—Cæcum.

Locality.—Pateros, Rizal, Luzon.

ECHINOPARYPHIUM RECURVATUM (v. Linstow, 1873) Dietz, 1909. Plate 7, fig. 2, and text fig. 4.

Domestic ducks from Pateros, Rizal, are often lightly infested with a small echinostome that differs from *Echinoparyphium recurvatum*, as described by von Linstow (1873) and by Dietz (1910) in the size of its various organs and eggs. In the number and arrangement of their cephalic spines, however, which characters are considered as most important in the determination of echinostomes in general, the two forms appear identical.

Description.—Body small, elongate, 2.10 to 4.32 millimeters in length by 0.43 to 0.48 millimeter in maximum width across acetabulum; lateral margins of forebody between suckers, which is constantly bent ventrolaterally in preserved specimens, rolled ventrally. Cuticle armed with numerous small spines, ventrally

from anterior end to level of testes and dorsally from anterior end to acetabulum. Head collar 0.28 to 0.30 millimeter in transverse diameter, armed with forty-five spines arranged in two alternating rows and grouped as follows: Four corner, ventral spines on each side, measuring in unstained specimens mounted in glycerine 87.3 to 91.5 by 18.7 to 20.8 microns; thirty-seven lateral and dorsal spines of two sizes, the aboral series measuring 74.8 to 82.8 by 16.6 to 20.8 microns and the oral series 60.3 to 66.5 by 14.5 to 16.6 microns. (The measurements of cephalic spines in stained specimens mounted in balsam are smaller; corner spines 66.5 to 74.8 by 16.6, aboral lateral and dorsal spines 64.2 to 70.7 by 12.5 to 14.5, and oral lateral and dorsal spines 44.0 to 58.0 by 12.5 microns.) Oral sucker measures 0.10 by 0.08 millimeter; prepharynx short or absent; pharynx 0.08 by 0.05 millimeter in size; œsophagus 0.38 to 0.52 millimeter long, bifurcates in front of acetabulum; intestinal cæca simple, narrow in diameter, extend to near posterior end of body.

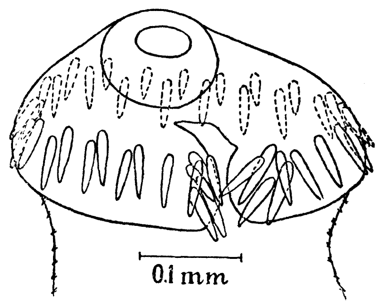

FIG. 4. *Echinoparyphium recurvatum* (von Linstow, 1873), cephalic collar and spines.

Testes oval to elongate, with smooth borders, tandem, very close together, postovarial; anterior testis usually shorter, 0.28 to 0.38 by 0.19 to 0.20 millimeter and posterior testis 0.36 to 0.41 by 0.18 millimeter in size. Cirrus sac 0.20 to 0.24 by 0.08 to 0.09 millimeter in size, extends posteriorly up to but not beyond equator of acetabulum; incloses seminal vesicle, pars prostatica, and cirrus. Common genital opening median, preacetabular, between œsophageal bifurcation and acetabulum.

Ovary median, globular or very slightly compressed, immediately postequatorial, 0.14 to 0.15 millimeter across. Shell gland rounded, slightly larger than ovary, between latter and first testis; receptaculum seminis absent, Laurer's canal present. Uterus very short, with very few eggs. Vitellaria in large follicles, extending from a little in front of level of ovary to near posterior end of body; follicles of two sides unite behind second testis. Eggs oval, yellowish, operculated, 79.0 to 83.5 by 54.0 to 58.2 microns in size (in mounted specimens).

Excretory bladder narrow in diameter, divides into two main branches behind second testis; excretory pore posteroterminal.

Host.—Domestic duck.

Location.—Small intestine.

Locality.—Pateros, Rizal, Luzon.

ECHINOCHASMUS NOVALICHESENSIS sp. nov. Plate 9, fig. 1, and text fig. 5.

This trematode is characterized especially by the size of its collar spines, of which the first two corner ventral ones are smaller and measure 42.4 to 45.7 by 10.4 to 10.8 microns; the rest of the spines are 46.6 to 54.0 by 10.4 to 12.4 microns in size. In the other members of the genus *Echinochasmus* listed by Dietz (1910) and by Odhner (1910), the cephalic spines are either of uniform or dissimilar sizes. If dissimilar, as in the case of *E. coaxatus* Dietz, 1909, the first three corner ventral spines are smaller, 60.0 to 76.8 by 16.8 to 19.2 microns, while the rest are 76.8 to 81.6 by 19.2 to 21.6 microns in size; in the case of *E. euryporus* (Looss, 1896, nec 1899), the spines become slightly larger in size from the dorsal to the ventral series and measure 45 to 54 by 14 to 18 microns.

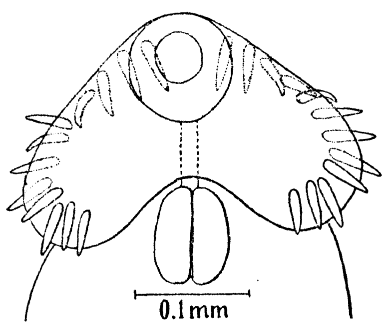

FIG. 5. *Echinochasmus novalichesensis* sp. nov., cephalic collar and spines.

Description.—Body small, elongate, 2.32 to 3.25 millimeters in length by 0.48 to 0.75 millimeter in maximum breadth across first testis; lateral margins between suckers inrolled ventrally. Cuticle armed with prominent, flat, scalelike spines from anterior end to level of first or second testis. Oral sucker terminal to subterminal, 0.08 to 0.10 by 0.10 to 0.12 millimeter in size; acetabulum, 0.22 to 0.26 by 0.25 to 0.32 millimeter, between anterior and middle thirds of body length or slightly anterior to that level. Head collar reniform, 0.26 to 0.32 millimeter across, armed with twenty-four blunt spines arranged in a single, dorsally interrupted row; the first two corner ventral spines on each side of collar are slightly smaller and measure 42.4 to 45.7 by 10.4 to 10.8 microns, the other spines measure 46.6 to 54.0 by 10.4 to 12.4 microns. Oral sucker separated from pharynx by

prepharynx 0.05 to 0.07 millimeter long; pharynx 0.08 to 0.10 by 0.08 to 0.09 millimeter in size; œsophagus 0.24 to 0.32 millimeter long, bifurcates in front of acetabulum; intestinal cæca simple, reaching to near posterior end of body.

Testes postequatorial, postovarial, tandem, with smooth borders, variable in shape and size; anterior testis spherical, oval or transversely elongate, measuring 0.20 to 0.38 by 0.19 to 0.34 millimeter; posterior testis spherical but usually oval to elongate and measures 0.22 to 0.42 by 0.20 to 0.30 millimeter. Cirrus sac oval, 0.16 to 0.32 by 0.10 to 0.18 millimeter in size, the greater part of its bulk projecting beyond anterior border of acetabulum, immediately behind œsophageal bifurcation; incloses small seminal vesicle, cirrus, and pars prostatica; seminal vesicle constricted at middle of its length. Genital pore median between œsophageal bifurcation and acetabulum.

Ovary equatorial or immediately preëquatorial, globular, 0.09 to 0.13 millimeter in diameter, usually to right side of median line; oviduct arises from its posterior border. Shell gland larger than ovary, median, in front of anterior testis; transverse vitelline ducts and vitelline reservoir dorsal, between shell gland and anterior testis; receptaculum seminis absent, Laurer's canal present. Uterus short, with very few eggs. Vitellaria in large, distinct follicles, extending from posterior level of acetabulum to posterior end of body; behind second testis the follicles of two sides are united. Eggs oval, yellowish, thin-shelled, operculated, measuring (in mounted specimens) 95.6 to 108.0 by 58.2 to 70.7 microns.

Excretory bladder long, with four pairs of side branches, and divides into two main branches behind second testis; excretory pore posterosubterminal.

Specific diagnosis.—*Echinochasmus:* Body 2.32 to 3.25 by 0.48 to 0.75 millimeters in size. Oral sucker measures 0.08 to 0.10 by 0.10 to 0.12 millimeter, acetabulum 0.22 to 0.26 by 0.25 to 0.32 millimeter; pharynx 0.08 to 0.10 by 0.08 to 0.09 millimeter; prepharynx 0.05 to 0.07 and œsophagus 0.24 to 0.32 millimeter long. Cephalic collar 0.26 to 0.32 millimeter across; first two corner ventral cephalic spines on each side smaller, 42.4 to 45.7 by 10.4 to 10.8 microns, the others 46.6 to 54.0 by 10.4 to 12.4 microns in size. Ovary 0.09 to 0.13 millimeter across; testes variable in shape and size. Vitellaria from pos-

terior level of acetabulum to posterior end of body. Eggs 95.6 to 108.0 by 58.2 to 70.7 microns in size (in mounted specimens).

Host.—*Hypotænidia torquata.*

Location.—Small intestine.

Locality.—Novaliches, Rizal, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 105.

HOLOSTOMES

STRIGEA MCGREGORI sp. nov. Plate 8, fig. 1.

The genus *Strigea* Abildgaard, 1790, has recently been divided by Szidat (1929) into six genera which, together with the genus *Apharyngostrigea* Ciurea, 1927, constitute the subfamily Strigeinæ Railliet, 1919. The genus *Strigea* (s. str.) is distinguished from the other genera by the distribution of the vitelline glands in both body regions, by the presence of a pharynx, and by the fact that the forebody is not much thicker than the hindbody. It comprises six well-defined species, with one of which, *S. falconis* Szidat, 1929, the parasite in question is most similar, especially with regard to the posterior extent of the vitellaria, the small size of the genital cone, the lobed testes, and the fact that the suckers are conspicuous. The two forms, however, may be differentiated as follows: *Strigea mcgregori* is much shorter, its ovary and eggs are smaller, its adhesive gland is large and more conspicuous, and the cuticle of its forebody is armed with very minute spines.

This parasite is named for Mr. R. C. McGregor, ornithologist of the Philippine Bureau of Science, who has kindly identified bird hosts for the writer from time to time.

Description.—Total length 1.94 to 2.28 millimeters; forebody distinctly marked off from hindbody, bell- or cup-shaped, 0.58 to 0.74 millimeter long, by 0.60 to 0.84 millimeter thick, the size of the opening of the cup in inverse proportion to the state of contraction of its walls; hindbody curved dorsally, 1.36 to 1.54 by 0.56 to 0.60 millimeters in dimensions. Cuticle of forebody armed with numerous, very minute spines. Oral sucker and pharynx 0.12 to 0.13 and 0.10 millimeter, respectively, in transverse diameter; œsophagus 0.07 millimeter long; acetabulum 0.22 by 0.20 millimeter in size, not hidden by vitellaria. Holdfast organ or attaching apparatus well-developed, attached to base of forebody; distally it is divided into three or more lamellæ which barely protrude beyond margin of cup.

Adhesive gland conspicuous, 0.18 by 0.26 millimeter in size, at junction between forebody and hindbody or a little anterior of that level, dorsal to acetabulum.

Testes compact, lobed (at least three lobes each), tandem, partly overlapping each other, postovarial, immediately behind equator of hindbody, 0.20 to 0.22 millimeter long by 0.33 to 0.36 millimeter thick. Vesicula seminalis well developed, coiled, behind second testis. Common genital pore on tip of small genital cone and communicates with the exterior through roomy sinus of modified bursa at posterior end of body.

Ovary spherical, 0.16 millimeter in diameter, at equator of hindbody. Oviduct arises from posterior border of ovary, is joined by Laurer's canal in front of anterior testis, continues posteriorly, and between the testes it meets with the vitelline duct and shell gland. Uterus moderately long; in some cases it reaches anteriorly up to near limit of hindbody, then bends suddenly ventrad and is continued posteriorly as a more or less straight canal; it leads to genital opening through thick-walled vagina. Vitellaria follicular, found in both regions of body; in forebody the vitelline glands are diffusely distributed, disappearing gradually towards margin of cup; in hindbody they are concentrated anterior and ventral to genital glands, reaching posteriorly only as far as beginning of genital bursa. Eggs oval, yellowish, operculated, thin shelled, 104 to 112 by 82 to 85 microns in size (in mounted specimens).

Specific diagnosis.—Strigea: Total length 1.94 to 2.28 millimeters; forebody 0.58 to 0.74 by 0.60 to 0.84 millimeter, its cuticle armed with minute spines; hindbody 1.36 to 1.54 by 0.56 to 0.60 millimeters. Adhesive gland conspicuous, 0.18 by 0.26 millimeter, at junction of body regions or slightly anterior. Oral sucker and pharynx 0.12 to 0.13 and 0.10 millimeter, respectively, in transverse diameter; œsophagus 0.07 millimeter long; acetabulum 0.22 by 0.20 millimeter. Ovary globular, 0.16 millimeter across, at equator of hindbody. Testes lobed, 0.20 to 0.22 by 0.33 to 0.36 millimeter. Genital sinus roomy, genital cone small. Vitellaria in both body regions, extending posteriorly up to beginning of genital bursa. Eggs 104 to 112 by 82 to 85 microns in size (in mounted specimens).

Host.—Butastur indicus.

Location.—Intestine.

Locality.—Calamba, Laguna, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 3.

PARASTRIGEA INTERMEDIA sp. nov. Plate 8, fig. 2, and Plate 11, figs. 1, 2, and 3.

According to Szidat (1929), the genus *Parastrigea* is similar to *Strigea* in the distribution of the vitellaria and in the form of the genital cone and bursa. It differs from the latter only in the presence of a pair of lateral projections or lobes on the cup-shaped forebody, the entrance into the cavity of which is small. The trematode under consideration possesses these generic characters, differing from *Parastrigea cincta* (Brandes) and *P. robusta* Szidat in that the lateral lobes of its forebody are not so very well developed (Plate 11, fig. 1). For this reason it may be considered as representing an intermediate form between the members of the genus *Strigea* and those of *Parastrigea*. In size it is also intermediate between *P. cincta* and *P. robusta*, *P. cincta* being the largest.

Description.—Body moderately large, distinctly divided into two regions, with a total length of 4.80 to 5.57 millimeters; forebody more or less triangular in shape, being expanded posteriorly into two not very prominent lateral lobes and measuring 1.78 to 2.00 millimeters in length by 1.10 to 1.45 millimeters in maximum width by 0.95 to 1.00 millimeter in maximum thickness; hindbody bag-shaped, constricted at its junction with forebody, measuring 3.02 to 3.62 by 1.15 to 1.20 by 1.13 to 1.15 millimeters. Oral sucker, pharynx, and acetabulum weakly developed, the latter being very close to pharynx; they measure, respectively, 0.10 to 0.12, 0.12, and 0.14 millimeter in transverse diameter. Holdfast organ well developed, filling up most of cavity of forebody; it appears solid at its base, but distally it is lamellated, the lamellæ usually protruding through narrow opening of forebody (Plate 11, fig. 3). Adhesive gland relatively small, 0.12 by 0.10 millimeter in size, near junction of body regions.

Testes behind equator of hindbody, postovarial, tandem, partly overlapping each other, very slightly lobed if at all, measuring 0.56 by 1.00 millimeter. Common genital pore discharges into cavity of small modified genital bursa at posterior end of body. Genital cone absent.

Ovary transversely oval, 0.36 by 0.54 millimeter in size, at equator of hindbody. Uterus moderately long, with fairly numerous eggs. Laurer's canal present, opens dorsally opposite level of first testis and meets oviduct in front of this organ. Shell gland and vitelline reservoir between testes. Vitellaria very well developed in both body regions; in the forebody they

occur in the lateral walls of the cup in the form of two thin lateral layers and in the substance of the holdfast organ in the form of two symmetrical winglike masses (Plate 11, fig. 2); in the hindbody they fill the regions anterior and ventral to reproductive glands, extending posteriorly up to beginning of bursa or a little beyond. Eggs oval, yellowish, thin shelled, operculated, 99.8 to 112.3 by 70.7 to 79.0 microns in size (in mounted specimens). Excretory pore ventral, near posterior end of body.

Specific diagnosis.—Parastrigea: Total length 4.80 to 5.57 millimeters; forebody 1.78 to 2.00 millimeters in length by 1.10 to 1.45 millimeters in maximum width by 0.95 to 1.00 millimeter in maximum thickness, with rounded, moderately developed lateral lobes; hindbody cylindrical, 3.02 to 3.68 by 1.15 to 1.20 by 1.13 to 1.15 millimeters. Oral sucker, pharynx, and acetabulum weak, measuring, respectively, 0.10 to 0.12, 0.12, and 0.14 millimeter across. Ovary 0.36 by 0.54 millimeter, testes 0.56 by 1.00 millimeter in size. Bursa small, genital cone absent. Vitellaria profuse in both body regions, extending from acetabular level to beginning of bursa. Uterus moderately long. Eggs fairly numerous, 99.8 to 112.3 by 70.7 to 79.0 microns in size (in mounted specimens).

Host.—Butastur indicus.

Location.—Intestine.

Locality.—Calamba, Laguna, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 11.

COTYLURUS MAMILLIFORMIS sp. nov. Plate 10, figs. 1 and 2.

Szidat (1929) in his revision of the genus *Strigea* assigned to his genus *Cotylurus* the following five species of holostomes parasitic in sea gulls and water birds; namely, *C. cornutus* (Rudolphi), *C. aquavis* (Guberlet), *C. erraticus* (Rudolphi), *C. platycephalus* (Creplin), and *C. variegatus* (Creplin). The last four species are said to possess lobed testes, a character that separates them at once from the parasite under consideration. There remains, therefore, only *C. cornutus,* the type species of the genus, which the new species resembles most closely but from which it differs in the more posterior position of its ovary and testes and in the size of the latter organs.

Description.—Body with a total length of 1.32 to 2.96 millimeters, divided distinctly into two regions; forebody 0.36 to 0.66 millimeter in length by 0.58 to 0.64 millimeter in maximum

width by 0.44 to 0.54 millimeter in maximum thickness; hindbody curved dorsally, measuring 0.96 to 2.30 by 0.60 to 0.64 by 0.40 to 0.50 millimeters. Cuticle smooth. Oral sucker ventroterminal, roundish, 0.091 to 0.095 millimeter across; acetabulum 0.130 to 0.175 by 0.140 to 0.175 millimeter, pharynx 0.054 to 0.062 by 0.045 to 0.054 millimeter in size; œsophagus 0.037 to 0.058 millimeter long; intestinal cæca simple, extending posteriorly just beyond vitelline glands. Holdfast organ attached to base of forebody and consisting distally of anterior and posterior lamellæ that protrude beyond ventral rim of cup-shaped forebody. Adhesive gland not very conspicuous, dorsal to acetabulum.

Testes tandem, very close together, immediately postovarial, behind equator of hindbody, transversely elongate, their extremities bent ventrally towards median line, 0.22 to 0.30 by 0.50 to 0.53 millimeter in size. Vesicula seminalis moderately developed; ejaculatory duct short, opens into common genital pore dorsal to vagina. Genital pore at posteroventral wall of sinus of genital bursa at posterior end of body. Genital cone absent.

Ovary slightly compressed, 0.18 to 0.20 to 0.22 millimeter in size, median, at equator of hindbody. Oviduct arises from posterior border of ovary and is soon joined by Laurer's canal which opens on dorsal surface of body at level of anterior testis; it is continued posteriorly and after receiving the vitelline duct and entering the shell gland in the region between the two testes, it bends anteriorly and becomes the uterus; the latter on reaching the level of the ovary turns ventrad and runs in an almost straight line towards the genital pore. Vitellaria in distinct, fairly large follicles, confined in hindbody where they occupy most of the space anterior and ventral to the reproductive glands and extend to near posterior end of body. Eggs few, oval, yellowish, thin shelled, operculated, measuring (in mounted specimens) 87.3 to 99.8 by 58.2 to 66.5 microns.

Excretory pore median, ventral, near posterior end of body.

Specific diagnosis.—Cotylurus: Total length 1.32 to 2.96 millimeters; forebody 0.36 to 0.66 millimeter in length by 0.58 to 0.64 millimeter in maximum width by 0.44 to 0.54 millimeter in maximum thickness, hindbody 0.96 to 2.30 by 0.60 to 0.64 by 0.40 to 0.50 millimeters. Oral sucker 0.091 to 0.095 millimeter across; acetabulum 0.130 to 0.175 by 0.140 to 0.175 millimeter, pharynx 0.054 to 0.062 by 0.045 to 0.054 millimeter in

size; œsophagus 0.037 to 0.058 millimeter long. Ovary 0.18 to 0.20 by 0.20 to 0.22 millimeter in size; testes 0.22 to 0.30 by 0.50 to 0.53 millimeter, behind equator of hindbody, their lateral extremities rolled ventrally. Eggs 87.3 to 99.8 by 58.2 to 66.5 microns in size (in mounted specimens).

Host.—Snipe (*? Gallinago gallinago*).

Location.—Intestine.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 13.

PROALARIA BUTASTURINA sp. nov. Plate 9, fig. 2.

Compared with the species assigned to the genus *Proalaria* by La Rue (1926, 1927), this fluke appears to be most closely related to *P. gavium* (Guberlet, 1922) in the shape and size of the testes and in the extent of the vitellaria. It differs from *P. gavium*, however, in the relative lengths of its two body regions, in the larger size of its holdfast organ, and in possessing a longer œsophagus.

Description.—Body slipper-shaped, 1.36 to 1.60 millimeters in total length, divided into two regions by slight circular constriction; forebody foliaceous, slightly longer than hindbody, 0.76 to 0.90 by 0.42 to 0.50 millimeter in size, its lateral margins incurved ventrally and meeting in median line behind holdfast organ; hindbody thicker, 0.60 to 0.70 by 0.34 to 0.40 millimeter. Cuticle smooth. Oral sucker subterminal, measuring 0.037 to 0.041 by 0.041 to 0.045 millimeter; acetabulum at or immediately in front of middle of forebody, 0.058 to 0.066 millimeter across; pharynx 0.041 millimeter across, œsophagus 0.066 millimeter long; intestinal cæca simple, reaching to near posterior end of body. Lateral earlike appendages, not very prominent, on each side of level of pharynx. Adhesive disc or holdfast organ elliptical, with elongated shallow cavity, 0.20 to 0.34 by 0.12 to 0.18 millimeter in size, in posterior half of forebody, immediately behind acetabulum and bounded laterally by intestinal cæca.

Testes transversely elongate, immediately postovarial, in front of equator of hindbody, 0.04 to 0.10 by 0.18 to 0.28 millimeter in size; they are not unlike a mammalian femur in shape, with their extremities extending laterally across intestinal cæca. Cirrus sac absent. Vesicula seminalis well developed; ejaculatory duct short, leading into dorsally located genital pore near posterior end of body.

Ovary median or very slightly to one side of median line, at junction of two body regions, 0.095 to 0.108 by 0.125 to 0.145 millimeter in size. Uterus short, in many cases extending almost in a straight line from ovary to genital pore. Shell gland and vitelline reservoir between testes. Vitellaria profuse, distributed throughout hindbody and in most of forebody, including holdfast organ, disappearing gradually towards anterior end at level of œsophageal bifurcation. Eggs few, small, colorless, thin shelled, operculated, averaging in mounted specimens 58.2 by 37.5 microns in size.

Excretory system in the form of a network, the details of which could not be determined. There are two prominent longitudinal vessels in the forebody lateral to intestinal cæca; excretory pore posteroterminal.

Specific diagnosis.—Proalaria: Total length 1.36 to 1.60 millimeters; forebody measures 0.76 to 0.90 by 0.42 to 0.50 millimeter, hindbody 0.60 to 0.70 by 0.34 to 0.40 millimeter. Œsophagus 0.066 millimeter long. Holdfast organ elliptical, 0.20 to 0.34 by 0.12 to 0.18 millimeter in size, with shallow cavity. Ovary measures 0.095 to 0.108 by 0.125 to 0.145 millimeter, testes 0.04 to 0.10 by 0.18 to 0.28 millimeter. Vitellaria distributed throughout hindbody and in greater portion of forebody, disappearing gradually up to level of œsophageal bifurcation. Eggs in mounted specimens average 58.2 by 37.5 microns in size.

Host.—Butastur indicus.

Location.—Small intestine.

Locality.—Calamba, Laguna, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 14.

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ILLUSTRATIONS

[Drawings by Mr. V. V. Marasigan; microphotographs by Mr. V. Ferrer.]

ABBREVIATIONS

ac, acetabulum.
agl, adhesive gland.
cp, cirrus pouch.
gc, genital cone.
gp, genital pore.
gs, genital sinus.
ho, holdfast organ.
ia, intestinal arch.
lc, Laurer's canal.
œs, œsophagus.
ov, ovary.
sg, shell gland.
t, testis.
ut, uterus.
vag, vagina.
vg, vitelline glands.
vgl, ventral glands.
vr, vitelline reservoir.
vs, vesicula seminalis.

PLATE 1

FIG. 1. *Cyclocoelium* (*Postpharyngeum*) *orientale* var. *eurhinus* var. nov., entire worm, ventral view.
2. *Notocotylus naviformis* sp. nov., number and arrangement of ventral glands.
3. *Notocotylus naviformis* sp. nov., entire worm, ventral view.

PLATE 2

FIG. 1. *Notocotylus intestinalis* sp. nov., entire worm, ventral view.
2. *Notocotylus intestinalis* sp. nov., number and arrangement of ventral glands.

PLATE 3

FIG. 1. *Philophthalmus problematicus* sp. nov., entire worm, ventral view.
2. *Philophthalmus rizalensis* sp. nov., entire worm, ventral view.

PLATE 4

FIG. 1. *Leucochloridium hypotaenidiarum* sp. nov., young adult form, ventral view.
2. *Leucochloridium hypotaenidiarum* sp. nov., large adult form, ventral view.

PLATE 5

FIG. 1. *Glaphyrostomum rallinarum* sp. nov., entire worm, ventral view.
2. *Psilochasmus longicirratus* Skrjabin, 1913, entire worm, ventral view.

PLATE 6

FIG. 1. *Echinostoma chloropodis* var. *philippinensis* var. nov., entire worm, ventral view.
2. *Echinostoma batanguensis* sp. nov., entire worm, ventral view.

PLATE 7

FIG. 1. *Echinostoma revolutum* (Froelich, 1802), entire worm, ventral view.
2. *Echinoparyphium recurvatum* (von Linstow, 1873), entire worm, ventral view.

PLATE 8

FIG. 1. *Strigea mcgregori* sp. nov., entire worm, lateral view.
2. *Parastrigea intermedia* sp. nov., entire worm, lateral view.

PLATE 9

FIG. 1. *Echinochasmus novalichesensis* sp. nov., entire worm, ventral view.
2. *Proalaria butasturina* sp. nov., entire worm, ventral view.

PLATE 10

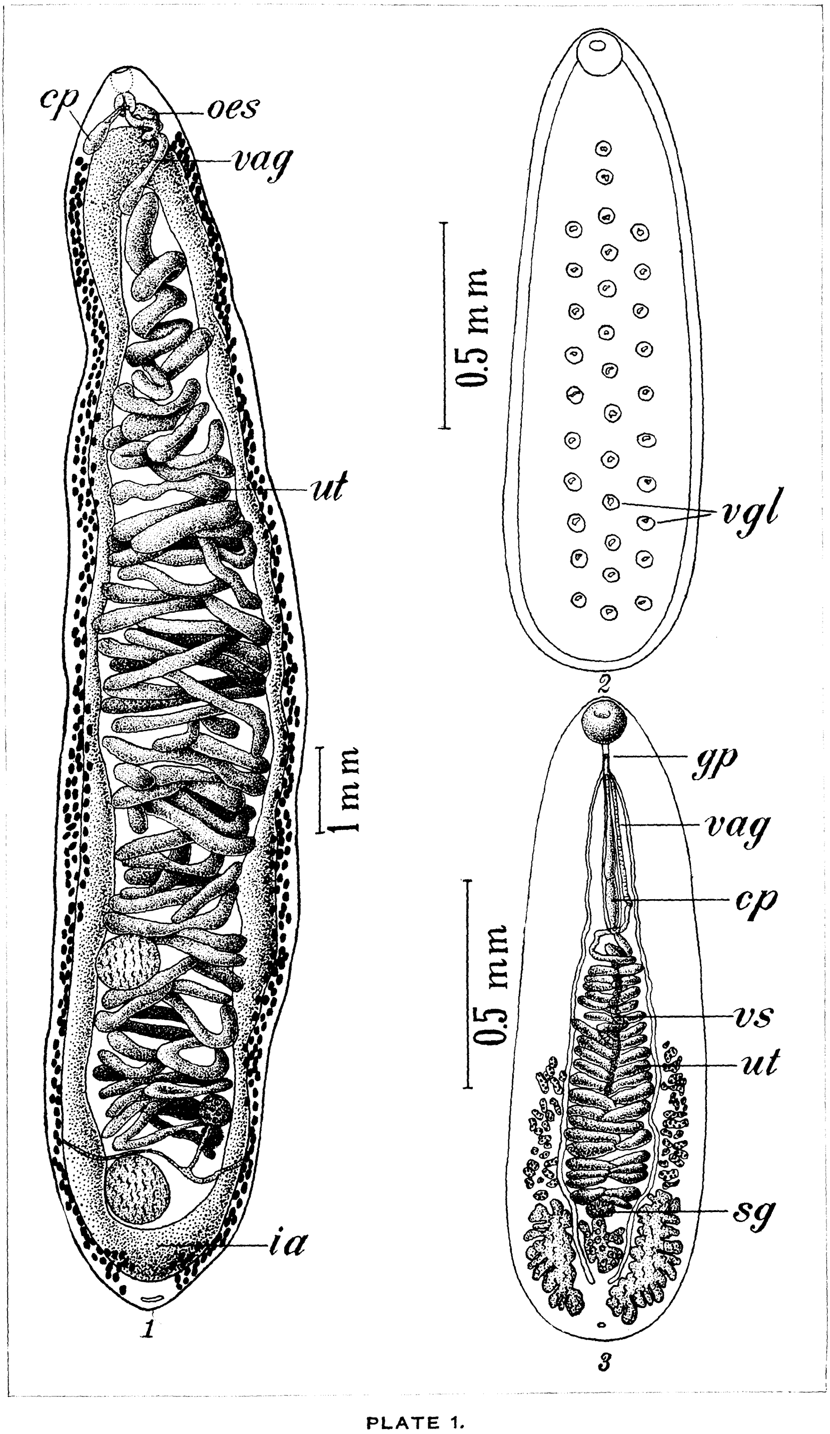
FIG. 1. *Cotylurus mamilliformis* sp. nov., entire worm, lateral view.
2. *Cotylurus mamilliformis* sp. nov., entire worm, ventral view.

PLATE 11

FIG. 1. *Parastrigea intermedia* sp. nov., entire worm showing shape of forebody, dorsal view.
2. *Parastrigea intermedia* sp. nov., cross-section through forebody.
3. *Parastrigea intermedia* sp. nov., median sagittal section.

TEXT FIGURES

FIG. 1. *Echinostoma chloropodis* var. *philippinensis* var. nov., cephalic collar and spines.
2. *Echinostoma batanguensis* sp. nov., cephalic collar and spines.
3. *Echinostoma revolutum* (Froelich, 1802), cephalic collar and spines.
4. *Echinoparyphium recurvatum* (von Linstow, 1873), cephalic collar and spines.
5. *Echinochasmus novalichesensis* sp. nov., cephalic collar and spines.



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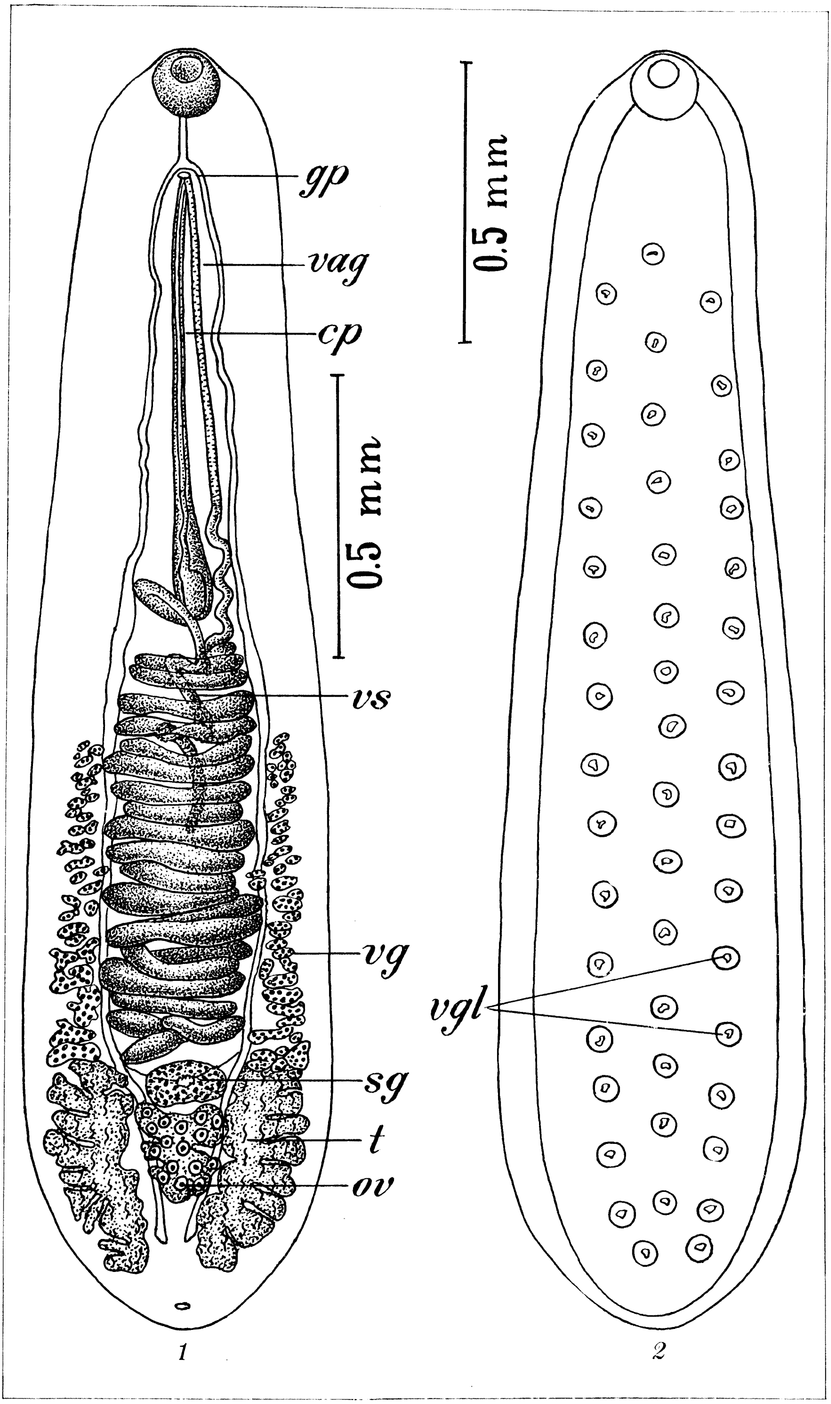

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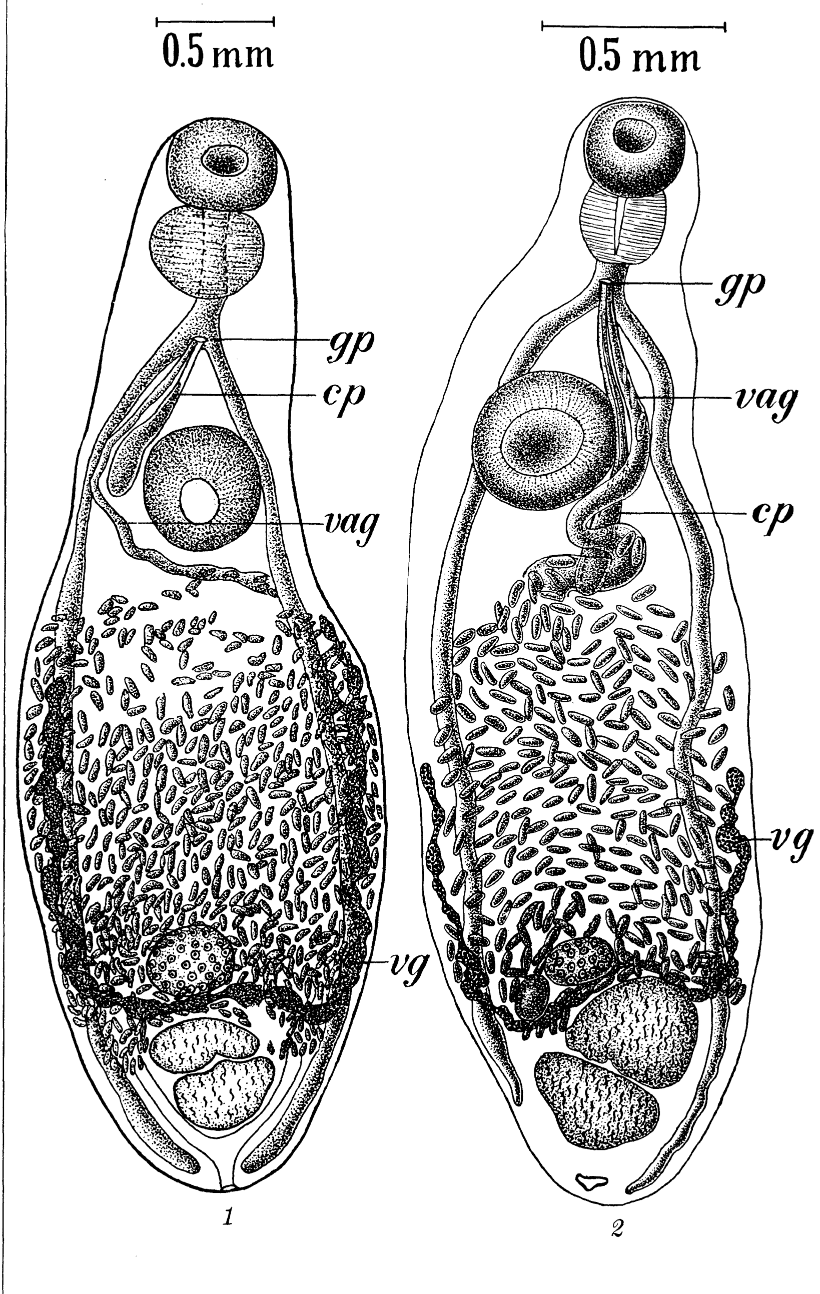

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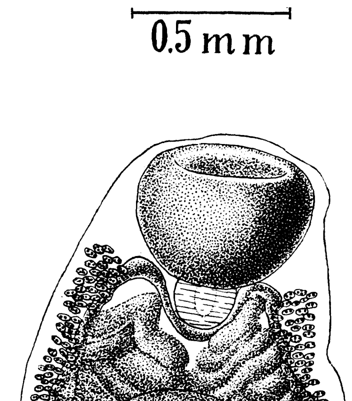

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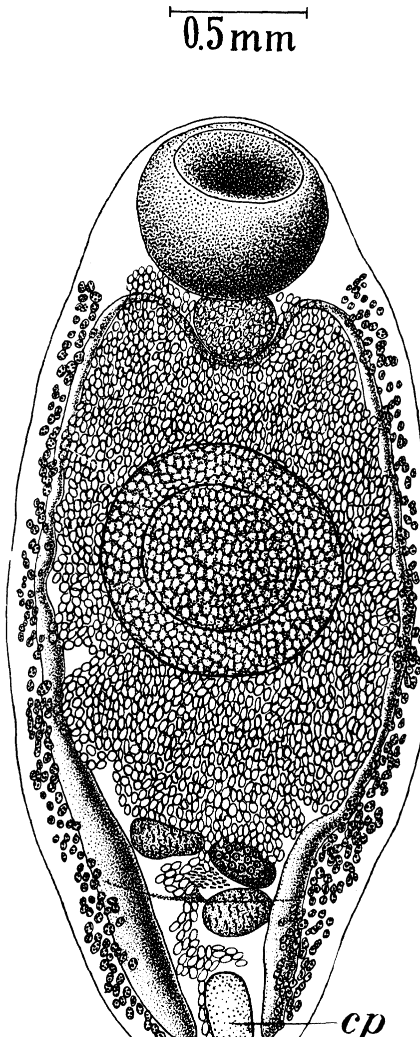

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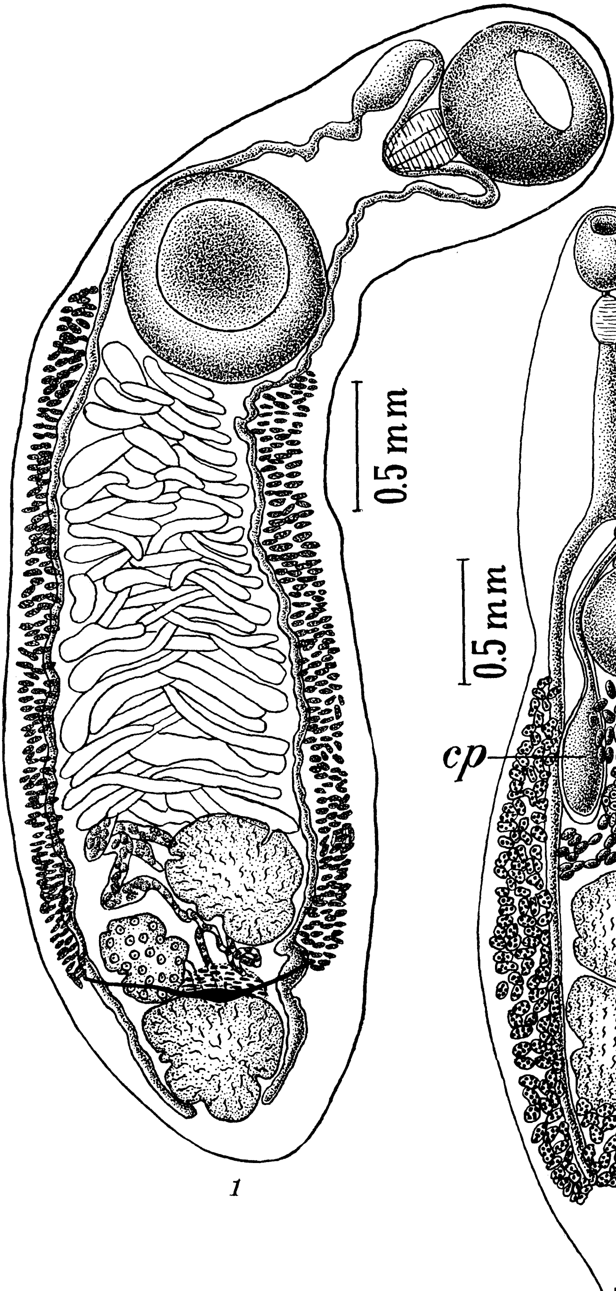

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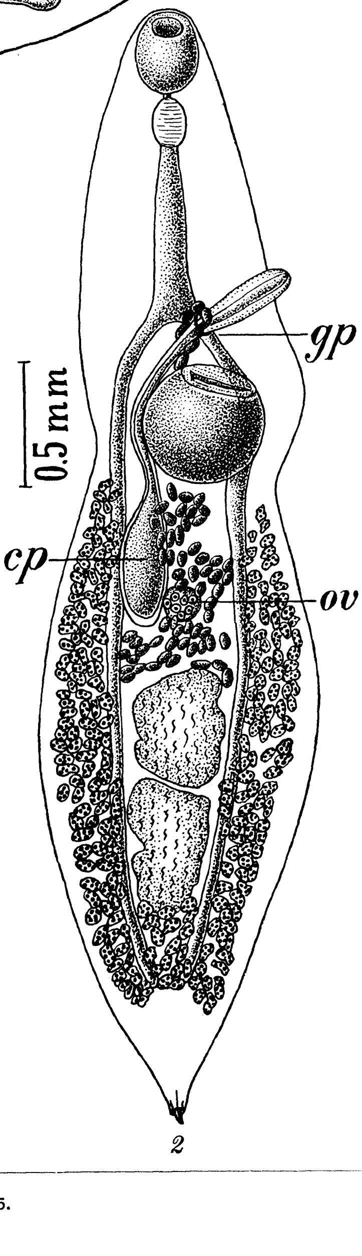

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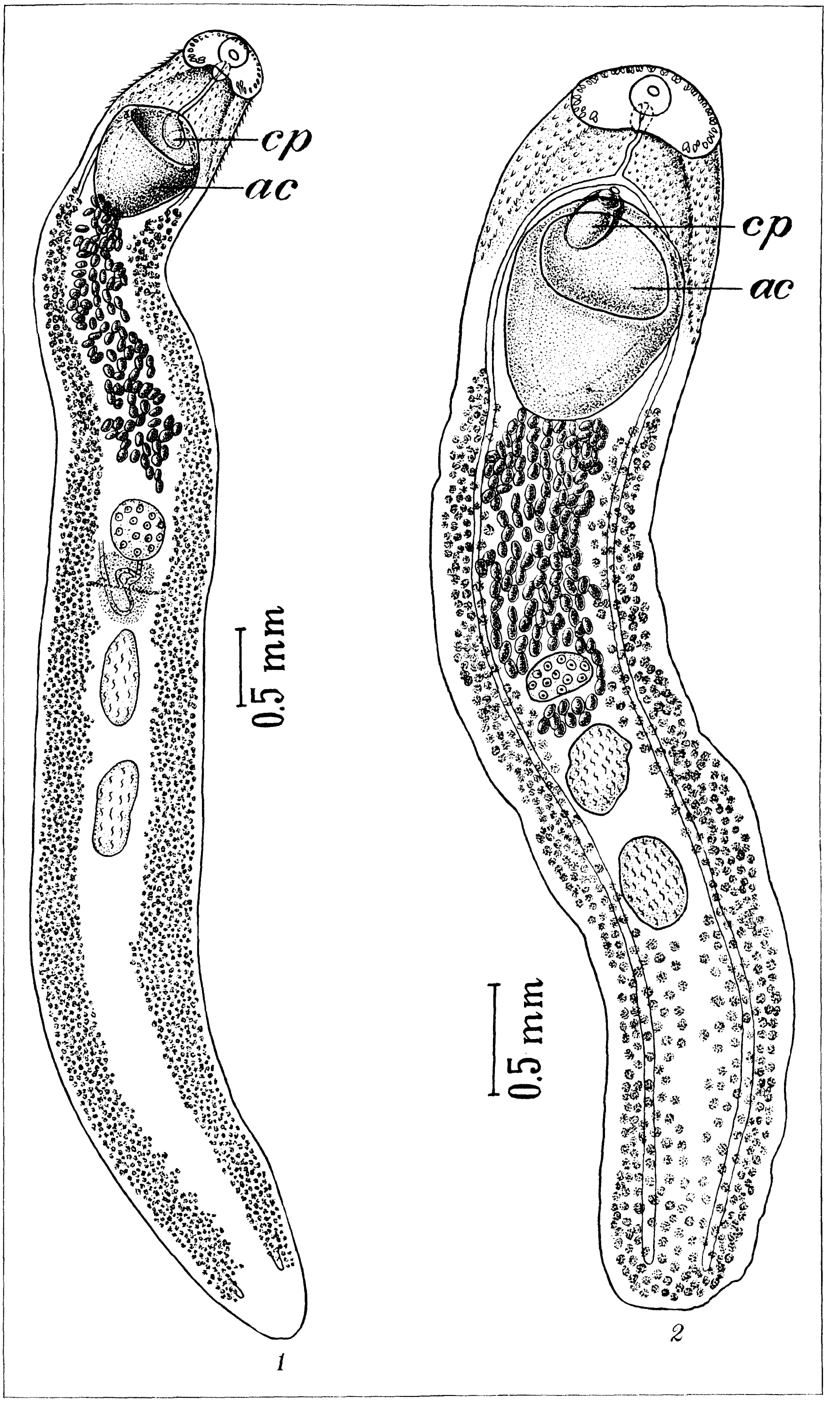

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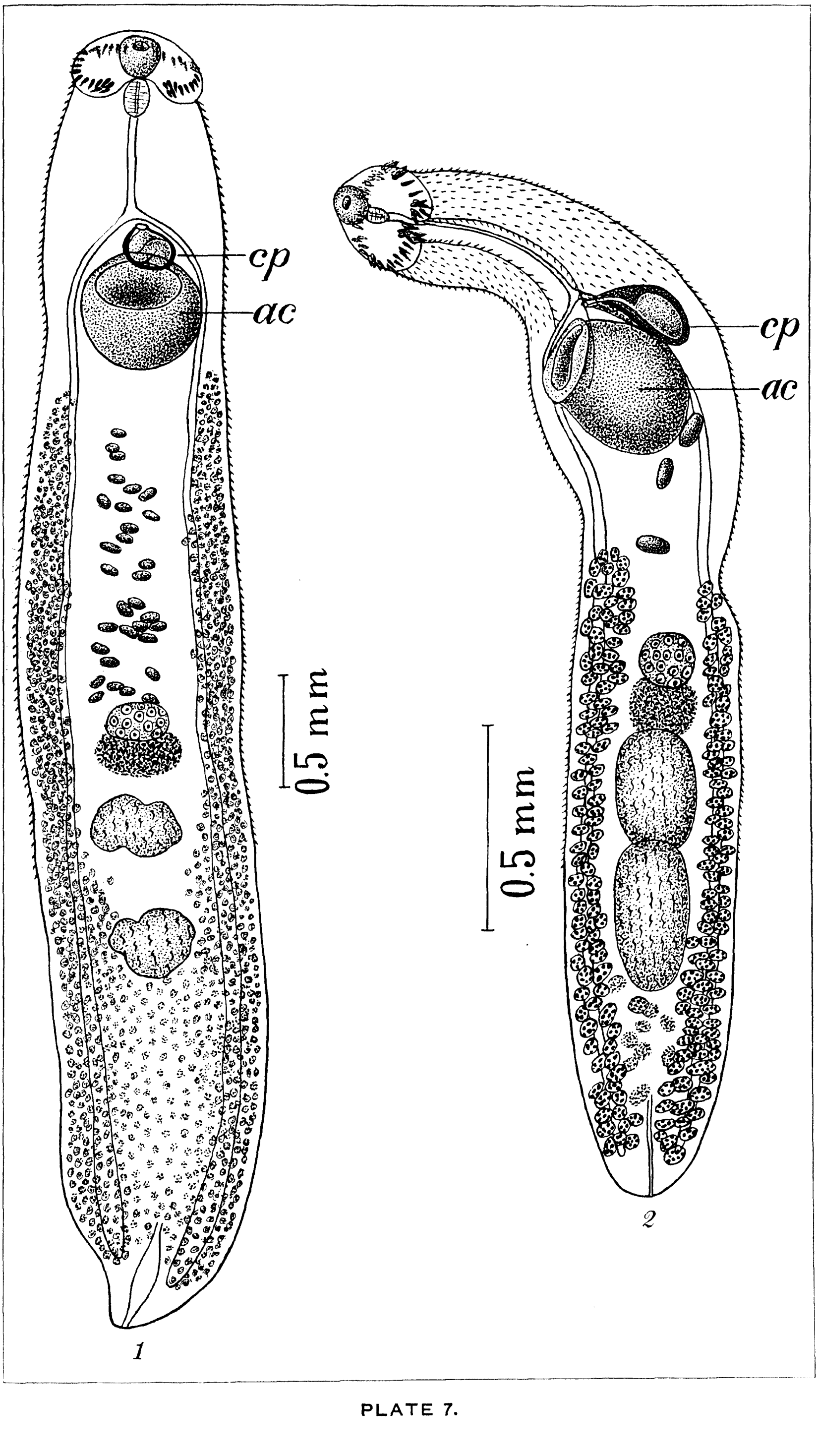

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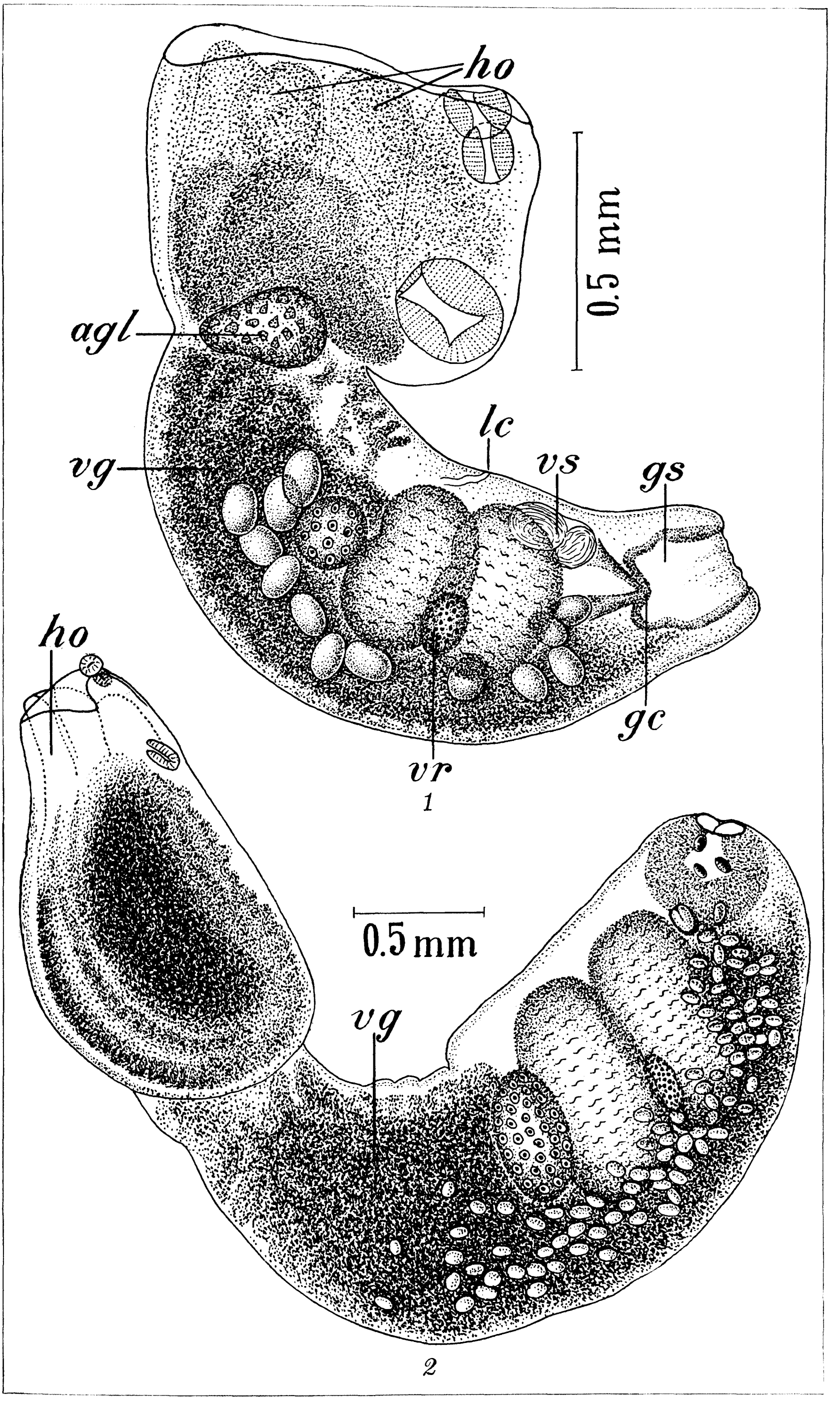

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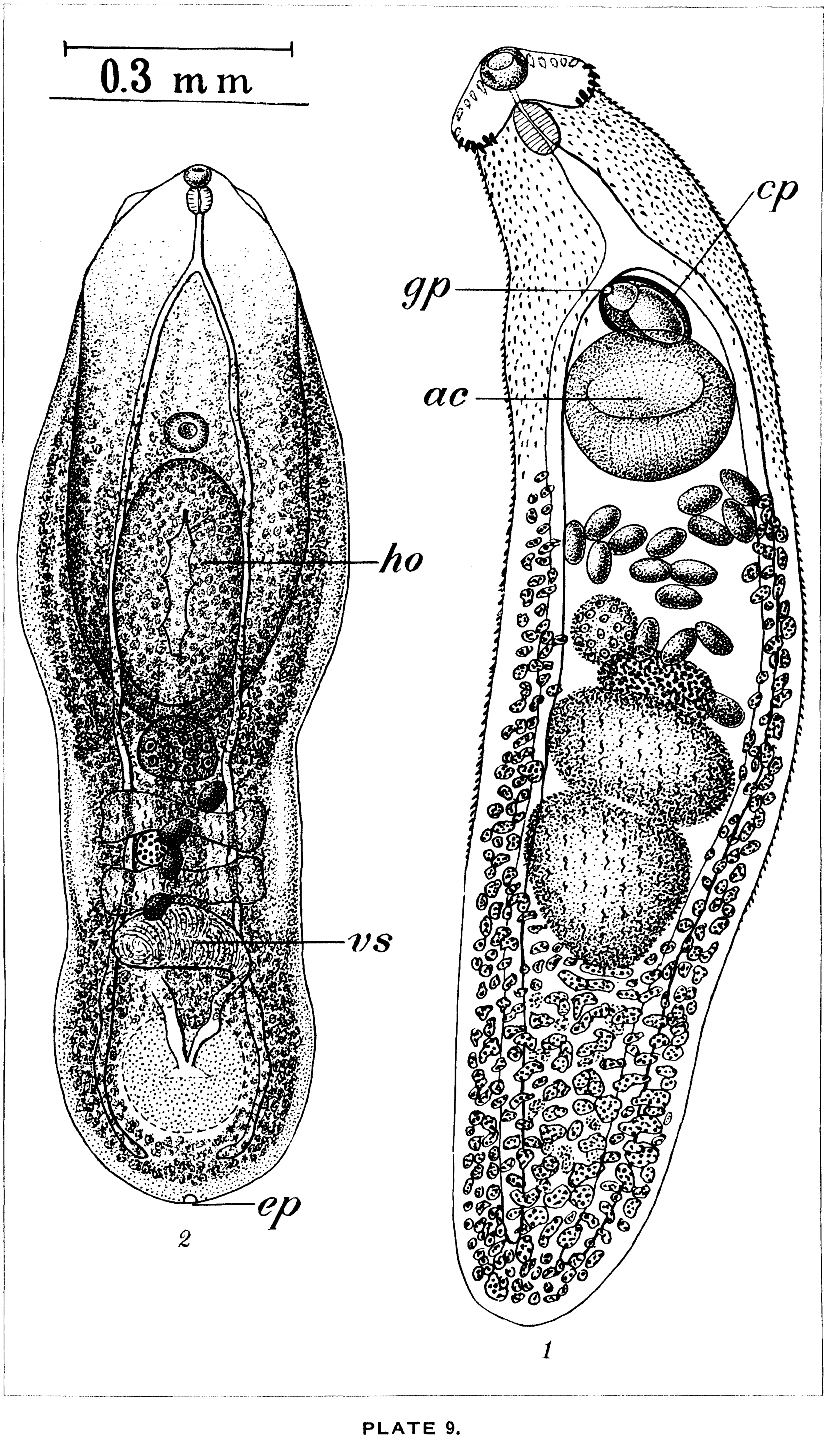

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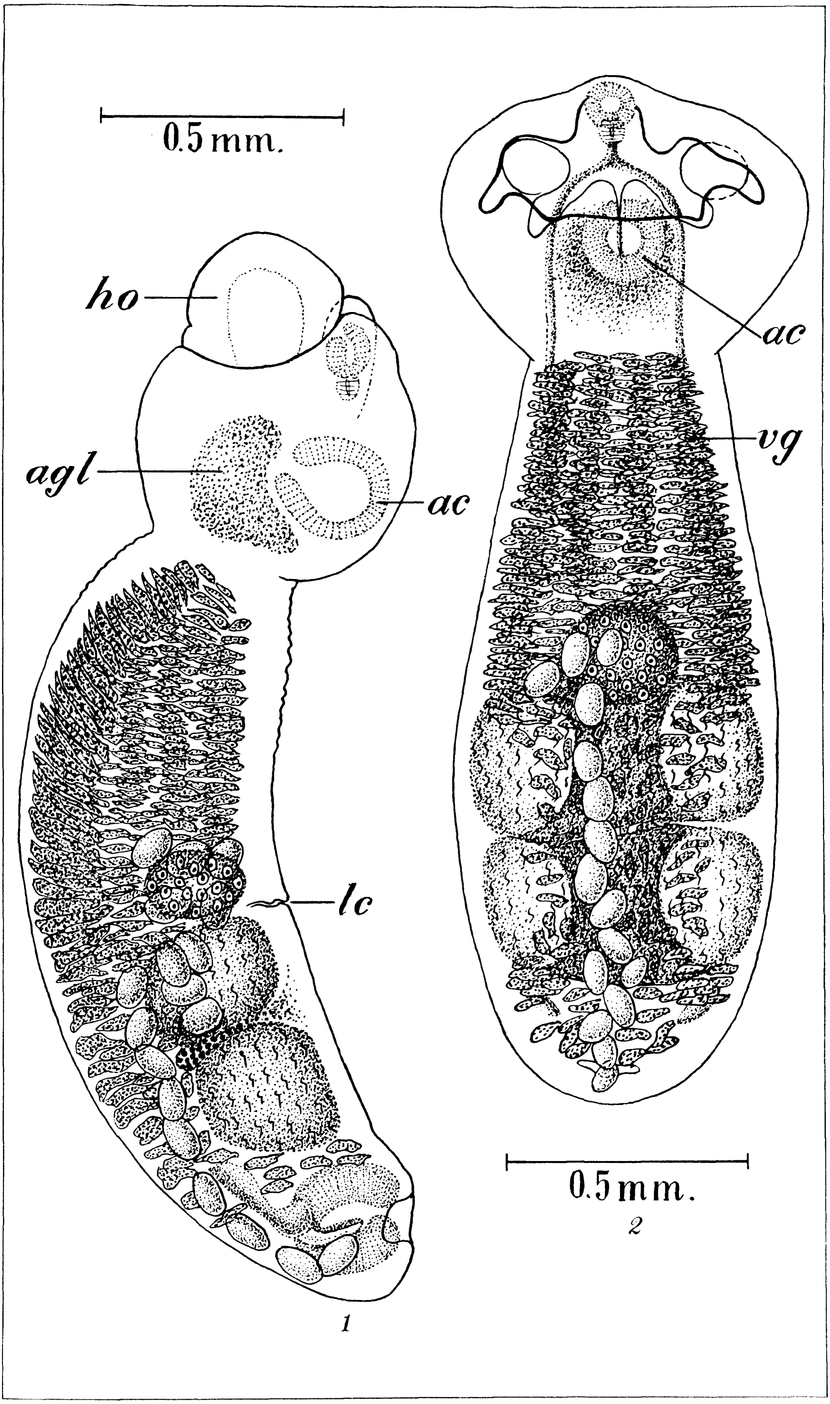

PLATE 10.

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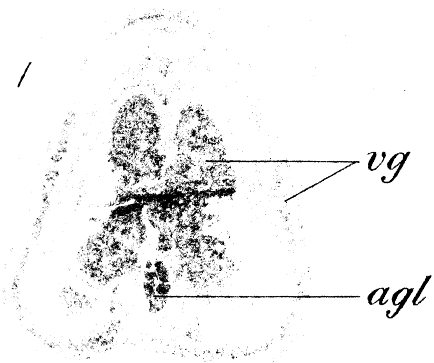

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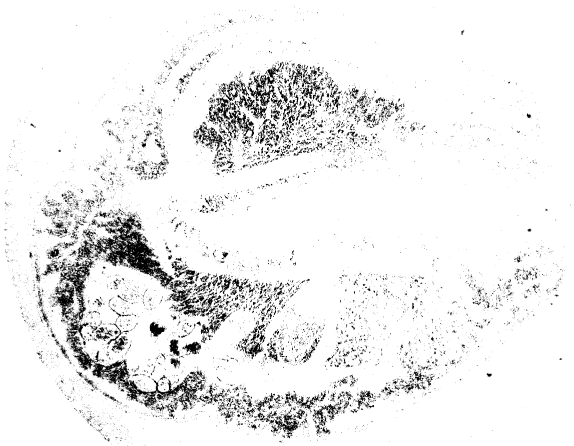

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PLATE 11.

FISHING METHODS IN MANILA BAY

By Vicente C. Aldaba

Of the Bureau of Science, Manila

FIVE PLATES AND SEVEN TEXT FIGURES

The rapid growth of the fishing population in the towns around Manila Bay has driven many fishermen to other Philippine coastal regions where there is less competition. Many fishermen from Naic have transferred their activities to Ragay Gulf, and a fishing village on the shore of San Miguel Bay is made up almost entirely of fishermen from Malabon. In many other places in the Philippines fishermen from Manila Bay are introducing their own methods of fishing.

Home seekers migrate to even a greater extent than do the fishermen. These settlers seek favorable locations along the coasts and rivers where natural transportation is available. If trained fishermen are among the settlers their struggle is made easier as they are taught new means of acquiring animal food, but, unfortunately, many communities are totally ignorant of fishing methods. This paper is prepared with the idea that it may be of help to such settlers.

SIMPLEST METHOD OF FISHING

The simplest method of fishing must be that in which the bare hands without apparatus are employed. Along the beach and in shallow rivers about Manila Bay, men, women, and children may be seen feeling for and catching fish with their hands under the water. Shrimps of various kinds, crabs, particularly the *alimasag* (*Neptunus pelagicus* Linnæus) and even *kanduli* (*Arius* spp.) are caught in this way. More enterprising fishermen inclose portions of rivers and ponds with mud embankments and then bail out the water with the help of pails or kerosene cans.

SPECIALIZED METHODS OF CAPTURING DIFFERENT KINDS OF FISHES

The difficulty encountered in capturing fish with the bare hands made it necessary for fishermen to think of easier and better ways. In doing this they were naturally guided by the

habits of the different kinds of fishes with which they had come in contact. Thus, methods adapted only for certain kinds of fishes have been developed.

The pangigat (*fig. 1*).—In many places around Manila Bay, especially in newly drained fishponds and muddy surfaces between tidal zones people may be seen at times dissecting the

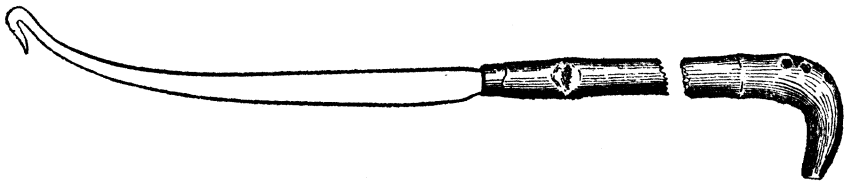


FIG. 1. Pangigat.

mud with an instrument called *pangigat*, a name derived from a certain kind of eel, the *igat* (*Synbranchus bengalensis* McClelland), which it is designed to catch. This fishing instrument is about 1.5 meters long and consists of two parts; namely, a handle of bamboo about a meter in length, and an iron rod with a hook at the end. When this instrument is driven into the mud and pulled out obliquely it hooks any igat that may be in the way. Usually the fisherman locates the hole of an igat before using the apparatus.

The pamalos (*fig. 2*).—To catch the large species of eel known as *palos* (Anguillidæ), the *pamalos*, a kind of spear with seven prongs, five pointing downward and two upward, is used.

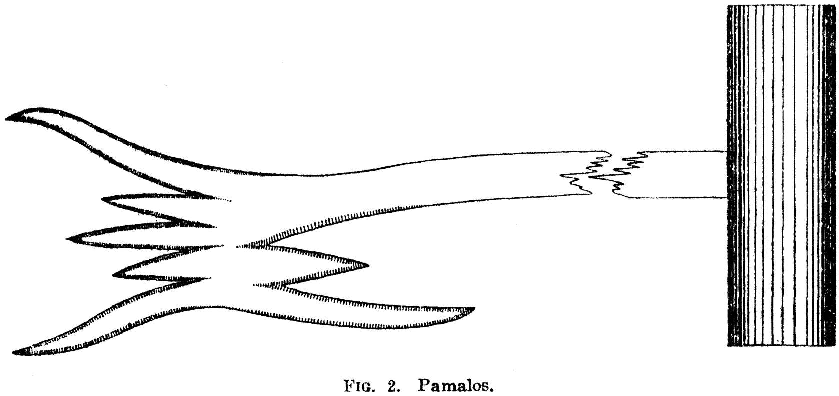


FIG. 2. Pamalos.

The habit of the palos is to retreat into a hole in the mud, and an experienced fisherman knows from its appearance whether or not a certain hole contains an eel. He drives his spear

deep into the mud around the hole, repeating this performance until he strikes the palos, of which he immediately becomes aware by a certain feeling, which he has learned to know from experience. The palos on being struck coils about the spear and is caught by the upper prongs. The fisherman then pulls out the spear with the catch.

In shallow rivers and along the coast of Manila Bay, in Bulacan, Pampanga, and Bataan Provinces, a kind of crab much valued as food, known as *alimañgo* (*Scylla serrata* Forskål), is caught in large numbers. There are several ways to catch this particular kind of crab.

The panukot.—The habit of the alimañgo is to make and hide in more or less horizontal holes. This has given rise to the use of the *panukot,* an instrument made up essentially of a bamboo pole and an iron rod, the latter bent so as to form an L, the upright leg of which is attached to and forms an extension of the bamboo pole (fig. 3). The length of the whole device depends upon the depth of the crab holes. A metallic sound is

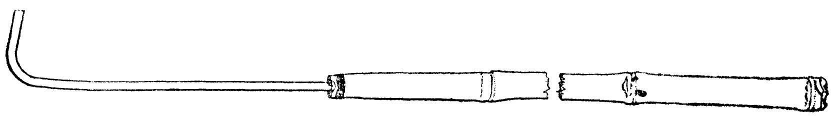


FIG 3. Panukot.

produced when the iron hits the hard coat of the crab, thus revealing its presence. By constant irritation it is made to hold tenaciously to the iron with its claws. The fisherman then throws the crab on its back by turning the pole over and pulls his catch out of the hole.

The tapañgan.—In Bulacan a trap known as *tapañgan* is used extensively to capture crabs. This device is cylindrical in general appearance, about 50 to 60 centimeters long, and about 20 centimeters in diameter. The cylinder is very slightly tapering toward each end. It is made of split bamboo tied in parallel order to four almost equidistant hoops whose diameters determine those of the trap. At each end of the cylinder is a funnel formed by pointed bamboo splints held together usually by rattan so that the pieces that converge inwardly into one point are free. Thus the crab can enter easily but cannot go out (Plate 1, fig. 1). The bait, which consists of dead fish or small living crabs, is contained in a small bamboo tube placed inside the trap. A number of these traps are set in shallow rivers and in nipa and mangrove swamps where they are covered

with water during high tide. A fisherman may have as many as forty or more set at one time.

The bintol.—Another effective trap for crab is the *bintol.* This consists of two pieces of bamboo each about 60 centimeters long set across each other perpendicularly, and a square net whose four corners are attached to the four ends of the two bamboo pieces. Because the diagonals of the net are shorter than the bamboo pieces, the latter are bent and the net is stretched; the whole affair forming a structure that is more or less rigid. The bamboo pieces are about 50 centimeters long and 2 centimeters wide, and carry lead or burned-clay weights at the ends. Hanging from the crossed bamboo pieces is a small bamboo tube that holds the bait. A float, of bamboo or wood, shows the location of the trap (Plate 1, fig. 3).

The crab in order to reach the bait uses its claws through the small holes of the bamboo container. When the trap is brought out of the water the crab ceases to struggle for the bait and tries to escape by letting itself fall. It is then caught on the net. A person fishing for crabs with bintol may set as many as a hundred at a time in rivers, estuaries, and along the seashore. He probably will visit them several times during the day if crabs are plentiful. He uses a pole with a hook at one end to lift the bintol out of the water, catching the string below the float.

The panti.—The *panti* is a larger affair and although it catches alimañgo it is really intended for alimasag. It is about a meter wide and varies in length from a few to 200 meters or more. Its lower side is weighted with iron-wire rings about 10 centimeters in diameter. There are no floats except a piece of bamboo at each end. The net is not, therefore, rigidly stretched vertically. The crabs swim close to the bottom and on striking the net become entangled and caught. This method of fishing is especially common in Puerto Rivas, Bataan Province, where there is a long stretch of gradually inclined seashore.

The tigpao.—A very simple but effective method of catching alimasag but one that calls for great skill is the *tigpao.* This is a dip net made of fine wire or cotton twine having a circular opening about 40 centimeters in diameter and being attached to a pole about 3 meters long. On the other end of the pole is a paddle. The fisherman stands at the bow of his banca paddling, at the same time scanning the water for flashes of light that betray the presence of crabs after dark. He swiftly uses

the dip net on the other end of the pole and takes the crab into the banca. Naturally this kind of fishing is done only during dark nights.

Probably the best-known and most commonly eaten crustaceans around Manila Bay are the various kinds of shrimps. Methods for capturing them are highly developed.

The sakag.—The commonest way of catching shrimps is with the use of a *sakag* (Plate 2, fig. 1). The net of the sakag varies in size of mesh depending on the kind of shrimps to be caught. For *alamang* (small shrimps) a sakag with *sinamay* netting is used. For larger kinds of shrimps, nets of varying mesh are used. The fisherman uses a light placed on his head to attract the shrimps.

The diacus.—The *diacus* is a bag net placed at the mouth of rivers that contain plenty of alamang. The bag is made of sinamay and may be 20 meters deep and 10 meters wide with the pocket gradually tapering towards the rear. The vertical dimension of the mouth depends on the depth of the river.

The bintol.—In Naic, Cavite Province, fishermen use a kind of bintol for alamang. The bamboo pieces are about 1.80 meters long and the net, which is made of sinamay, is about 1.10 meters square. A float of bamboo is used (Plate 1, fig. 3).

The apparatus is placed in river beds. There is no bait of any kind and why the alamang stay in the net is not readily explained. In former days dried banana leaves were placed inside the bintol. The idea was to provide a sort of playground or home for the alamang, but it was discovered that the leaves could be dispensed with.

The kimpot.—In the upper part of the Pampanga river the people use a trap that they call *kimpot* for catching shrimps. This is similar to the tapañgan in form. There is, however, only one funnel; the other end tapers to a narrow opening provided with a stopper. The catch is drawn out of this opening. It is baited with roasted tikitiki in balls, corn, or peelings of grapefruit. According to the fishermen, the bait serves to attract the shrimps (Plate 2, fig. 2).

The lawiswis.—An interesting apparatus for catching shrimps is known in Bulacan as *lawiswis* and in Pampanga as *kalaskas.* It is essentially a narrow banca about 7 or 8 meters long with a sort of platform made of bamboo slats a little shorter than the banca itself, and about 50 centimeters wide firmly attached to one side. To balance this structure, larger bamboos, usually

two or three, are attached to the other side of the banca. In Pampanga pieces of *palma brava* (*Livistona* sp.) are more often used. A bamboo pole to which are firmly attached on one side a number of small tapering bamboo splints forms the lawiswis or kalaskas, the name adopted for the whole apparatus. The splints vary gradually from 0.5 to about 1 meter long towards the bow. The lawiswis is held by a vertical wooden pin at one end of the banca. It can, therefore, move only in two directions. (The splints are on the same side of the banca as that to which the platform is attached.)

The fisherman chooses for his fishing ground a sandy bottom with water about knee deep. He then grasps the end of the banca with one hand, the pole with the other and tips the banca to one side so that the ends of the splints touch the bottom. He pushes it with some speed, the splints whipping the water as the banca is pushed along. The shrimps jump on being disturbed and many of them land in the banca (Plate 3).

The pangugnat.—In Bulacan and in Bataan a species of goby known in these localities as *ugnat* (*Oxyurichthys microlepis* Bleeker) is captured almost exclusively by a unique method in which dried banana leaves and a stationary sakag play the main rôle. Two men operate this fishing apparatus, called *pangugnat,* one handles the sakag, and the other manipulates a line 100 meters long, usually made of *cabo negro* [fiber of a palm, *Arenga pinnata* (Wurmb) Merrill] to which dried banana leaves are attached in a parallel manner. The line is weighted usually with burnt clay, lead not being much favored because of its tendency to sink in the mud.

Fishing is carried on near the seashore where the water is about breast-deep. The man who handles the sakag stands stationary. By his side is a stake to which is tied one end of the line. The man holding the other end of the line describes an arc with the stake as center and the line as radius. At about the end of his trip he approaches the sakag, gradually shortening the line as he does so. The whole operation of the line has for its object the driving into the sakag of the gobies that happen to be in the area included within the section described by the operator. The sakag is then lifted out of the water and the fish collected. The fishermen then move to another place.

The katigbi.—The *katigbi* is operated in a somewhat similar manner to the preceding apparatus but it catches mainly *aligasin* (Mugilidæ). In place of the sakag is a bag net and instead of the line with banana leaves is one carrying thin pieces

of coconut husks. Ordinarily the line is about 50 meters long. It carries no weight and, therefore, stays on the surface of the water. Two men hold the net in position and another two manipulate the line, each holding one end. Starting from a distance the linemen approach the bag with as much speed as

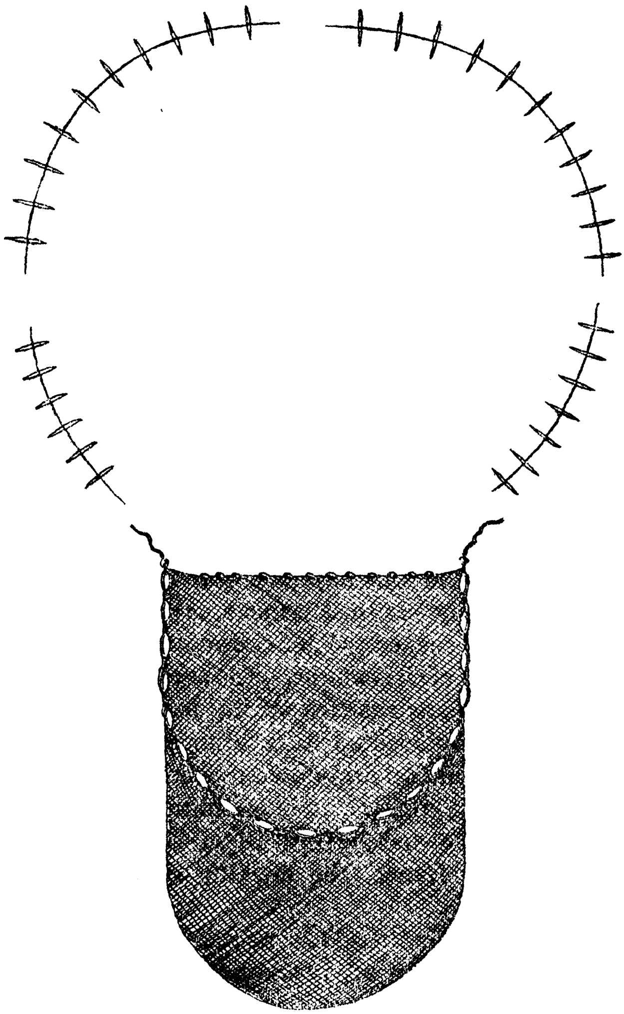


FIG. 4. Katigbi.

they can make in the water. As soon as the bag is reached, they shorten the line hurriedly. The men holding the net then lift the lead line so that the entire opening is above the water. The catch is collected after the bag is hauled into the banca. Another place is then selected for the next operation (fig. 4).

The gill nets.—Pelagic fishes, especially those that go in schools, are readily caught in large quantities in gill nets. This fishing gear is essentially a net with a mesh large enough for the fish to push its head through but not the body. When the fish backs out, the net becomes caught between the gill-cover and the shoulder bone. The fish is then said to be "gilled." Naturally, the mesh of a gill net is of the size that would gill the species for which it is intended.

The bating.—There are several kinds of gill nets in common use in Manila Bay. The most important is the *bating* for catching herrings of which there are a number of species; namely, *tunsoy* (*Harengula moluccensis* Bleeker), *tamban* (*Harengula longiceps* Cuvier and Valenciennes), etc. The net has a mesh of about 2.8 centimeters stretched and is usually about 720 meters long but may extend to 1,000 meters and is about 15 to 20 meters deep. A complete outfit would represent an investment of from 5,000 to 7,000 pesos, including a large banca, and requires for its operation from twenty to thirty people. The banca is usually towed by a launch around the bay, until a school of sardines is located when the banca is loosed. The net is then laid out to surround the school, and the sardines are driven to the net by people who beat the water with special poles carrying a club and noise-making device at one end. The operation is usually in the daytime and it is quite a sight to see a number of fully manned bancas carrying bating as they are towed by their respective launches around a place where sardines have just been caught. In each banca there is a watch tower, which consists of a strong bamboo pole. A school of sardines is readily located at a distance if the weather is clear, on account of the up-and-down movements of the sardines. If a bating has made a catch it is an indication that there are many other schools near-by since all of these are really parts of a larger school. Hence, the flocking of the bancas around the one place.

In Manila Bay alone there are about eighty of this type of fishing gear, representing an investment of nearly half a million pesos.

The panglambang.—The *panglambang* is similar to the bating except that there are two bancas, each carrying a net and moving toward each other in order to inclose a school. It requires, therefore, more men and usually more capital.

The largarete.—The *largarete* is much smaller than the bating, consisting of a net only 20 meters long and 15 to 20 meters deep. It is placed parallel to the banca, each end attached to one of two bamboo poles that are projected from the bow and stern of the banca. At night light is used to attract the fish.

The kansisi.—The *kansisi* is still smaller than the largarete and is used to gill herrings.

The patibog.—The *patibog* is a gill net for different species of aligasin. It is operated in the daytime, and once the school is encircled the fish are driven into the net by beating the water as in the bating.

Other gill nets.—There are gill nets for other kinds of fishes and one with a large mesh about 10 centimeters stretched is used for *tanguingue* (*Scomberomorus commersoni* Lacépède). The *pangjoya* is a small affair to catch bottom fishes, mainly the slipmouth (*Leiognathus* spp.). It is only 1 to 2 meters deep and 50 to 60 meters long. The weights are heavy enough to take the whole net to the bottom of the sea, the float being of sufficient buoyancy to keep the net vertical. An interesting net, although not common, is the one for gar, or needle fishes (Belonidæ). It carries a float but no weight, and the fish are caught by entangling their beaks in the net.

METHODS FOR CATCHING FISHES IN GENERAL

The most important kind of fishing apparatus in Manila Bay is the fish corral, locally known as *baclad*. The availability of bamboo, which is the most important material that goes into the making of a fish corral, must have had a great deal of influence on its development. The other important fishing apparatus that are made of bamboo are the *bobos* of which there are many shapes and sizes (Plate 2, fig. 3, and Plate 4). The nets of different kinds come next to fish corrals in importance.

There are two main types of fish corrals; namely, one with two wings and the other with a leader. Where the current is likely to be strong and shrimps are abundant the former type is the one usually constructed. In the open sea where there is hardly any current and where fish are more plentiful, a baclad with a leader, a heart, and two pounds is usually found. There are various modifications and combinations of these two types.

The bakikong.—The *bakikong* is the smallest fish corral to be found in regions around Manila Bay and consists of only a

small heart with a woven-bamboo bottom. It is about 0.5 meter in diameter and 1 meter high, with two very short wings, less than 0.5 meter long. This is placed before an opening in the dam of a rice paddy that is being drained of excess water.

Some rice paddies around Manila Bay are under water at high tide during June and July. Here shrimps are caught in quantities with the bakikong during August and September.

The palapad.—Those engaged in fishing with this apparatus choose a level or slightly inclined sea bottom that is under water at high tide and almost entirely exposed at low tide. This kind of place is usually found near the seashore. When the water has about reached its highest mark the fisherman incloses an area more or less semicircular, about 200 meters or more in radius, although many times it is less than this. When the water is low the fish are collected and another place is located for the next coming of the tide.

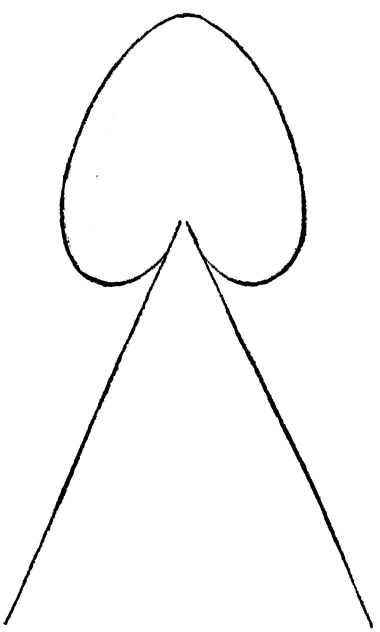


FIG. 5. Diagram to show the construction of a bunuhan.

The bunuhan.—The *bunuhan* is found in rivers where a strong current is produced by the receding tide in the bay. It varies in dimensions depending on the depth and width of the river. The wings, especially, are likely to be long. It catches many shrimps, but may catch any fish that happens to be carried by the current into the pound (fig. 5). The heart is complete in itself with a woven-bamboo bottom.

The abang.—The *abang* is similar to the bunuhan, but is a larger affair and is used in deeper rivers.

The sinipete.—The *sinipete* has also two long wings but has two or three pounds, the first leading into the second and the second into the third.

The aguila.—The general type of baclad in Manila Bay is that with a leader. In shallow waters near the seashore, especially, the leader is placed at right angles to the shore. At the end of the leader away from the shore is a more or less semi-

circular inclosure, the heart, the center of which lies somewhere in the leader. At each end of the semicircumference there are usually two pounds, one leading into the other (fig. 6). This type of baclad is known locally as *aguila* (a mythical double-headed bird) or *ancla* (anchor).

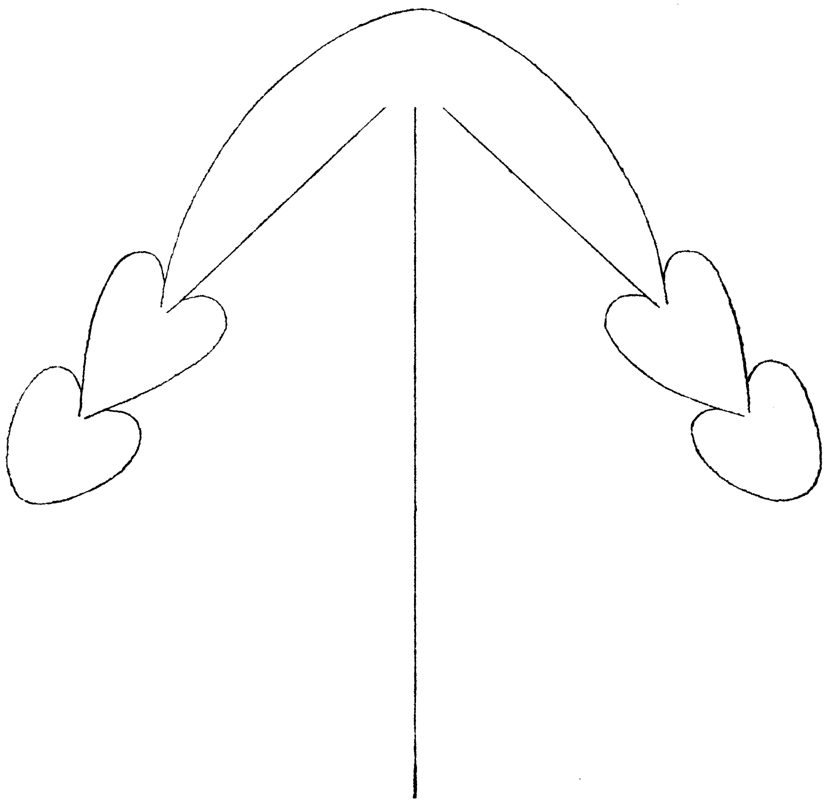


FIG. 6. Diagram to show the construction of a fish corral of the aguila type.

Along the shore of Bulacan, which slopes gradually into the sea so that for a long distance from the beach the water is shallow, the aguila is the type most commonly met with. The baclad is low and is, therefore, not so expensive, costing from 80 to 250 pesos. A small dip net is used to collect the fish from the pound.

The linea.—In Navotas, Salinas, and Orion where the shore declines more rapidly, so that there is deep water at a convenient distance from the shore, deep-water corrals (*lineas*) have been developed more than anywhere else in the bay. The

deep-water corral differs in form from that of the shallow-water aguila in that only one end of the heart is provided with one or two pounds. The fish are collected with a net requiring from seven to fifteen men to manipulate. The baclad is expensive and may cost from 2,000 to 4,000 pesos. Some baclad may be used in water 15 meters deep (fig. 7).

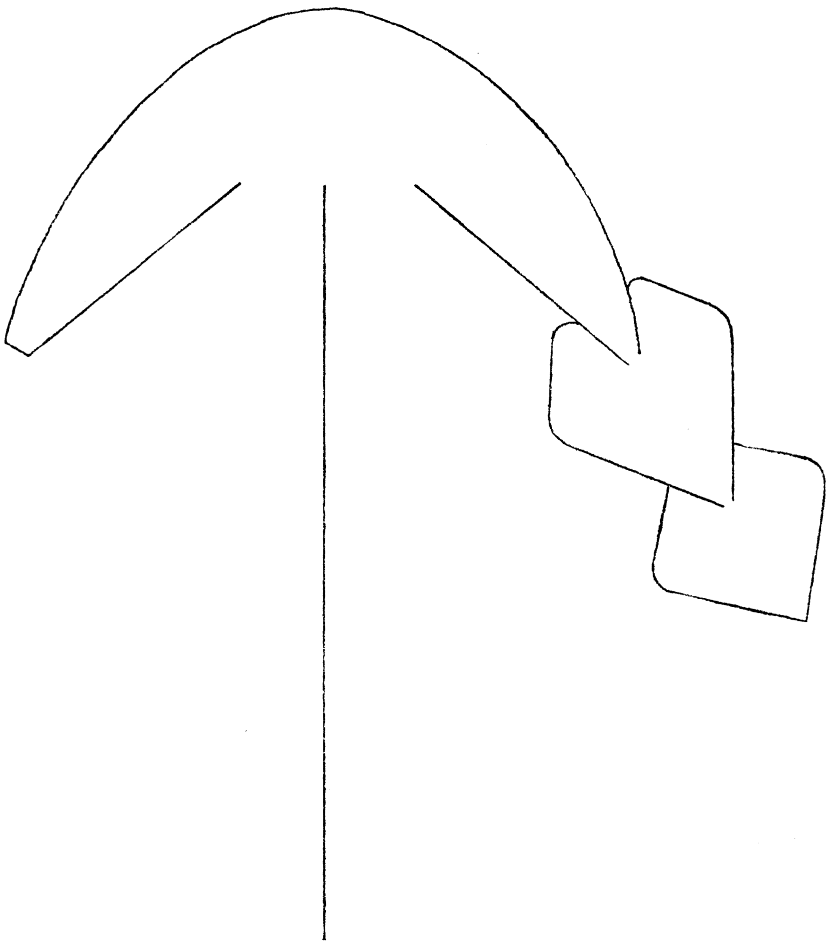


FIG. 7. Diagram to show the construction of a deep-water fish corral.

The ordinary bobo.—The commonest and easily the most important *bobo* to be met with in Manila Bay is the one shown in Plate 2, fig. 3. It is provided with one funnel and is what is usually referred to when bobo is spoken of. This is a very important fishing apparatus in Orion, Bataan, and in Naic and

Salinas, Cavite. In Bulacan it is also quite important, but in Pampanga it is seldom used. The bobo used in shallow water is comparatively smaller and is baited with alga. Usually it catches *samaral* (*Teuthis* spp.). In Salinas and Naic the bobos are larger and are intended for deep water. They then catch groupers mainly. A fisherman may have as many as 200 bobos placed at the bottom of the sea in different places. He visits about 15 to 16 every day so that a bobo is visited about once every two weeks.

The locating of these bobos in deep water is quite a problem and requires a good deal of experience. No markers of any kind should be left on the surface of the water to indicate the location of a bobo since other people may take the fish and even the bobo itself while the owner is absent. Before dropping a bobo in a place, the intersection of two lines made by landmarks at a distance, usually the peaks of mountains or church towers, is determined. The bobo is weighted so that it stays at the bottom and to it is attached a cabo-negro rope about 5 meters or more in length with a weight at the loose end. To bring a bobo to the surface of the water the fisherman uses an iron hook which he drags along the bottom until he catches the rope attached to the bobo.

The sullang.—In deep-sea baclad there is sometimes placed inside the pound a kind of bobo known in Bataan as *sullang.* This is placed in the water with the funnel up and is supposed to catch fish that dive straight from the surface to the bottom (Plate 4). In Salinas only the owner can put a sullang in the corral, while in Orion it is a privilege given by the owner of the baclad to the men who are working with him.

The bonbon.—As the name *bonbon* implies, this is a pile of branches and twigs in shallow water. The idea is to provide a sort of playground and home for different kinds of fishes. In order that the materials be not carried away by water the branches are stuck into the mud. After a certain time, usually about two weeks, the pile is inclosed in a baclad and the branches and twigs are taken out. The fish are then caught by narrowing the inclosure gradually. A dip net is used to take the fish out if the water is of considerable depth.

The salakab.—Strictly speaking this fishing gear is for fresh-water fishes, such as those that are collectively known as mudfishes, and is therefore properly treated in detail in a paper on fishing methods in Laguna Bay. But in Manila Bay, in small

shallow rivers, and in fishponds that are being drained the *salakab* is a very handy fishing gear to catch fish with in shallow water. The usual size varies from 25 to 50 centimeters in diameter and from 50 to 100 centimeters in height.

Hook and line.—The hook and line is probably the cheapest and most easily obtained fishing gear in regions around Manila Bay. Any boy can have a fishing rod most anywhere merely by securing a small branch of bamboo. With a short string, an ordinary bent pin for a hook, and some small shrimps or sandworms for bait and he is ready to go fishing. Ordinary fish hooks are of course procurable in the stores, though many fishermen prefer to make their own hooks. Fishermen from Naic and Orion use a trolling line known as *sibid-sibid,* the hook of which is baited with white chicken feathers tied around a small bamboo ring. Fishing is done in a fast sailing banca so that as the line is dragged along the water the feathered ring revolves continuously. The turning feather is supposed to attract the fish. Tanguingue is usually caught.

The kitang.—This is a line about 200 meters long, to which are attached about a meter apart many short lines or snoods each carrying a hook. Usually from 100 to 200 hooks are used. The line is placed stationary at the bottom of the sea with a float to indicate its position. This kind of trawl-line fishing is found in Cavite, Bataan, and Bulacan mainly.

In Bataan the pangugnat and the *kitang* form a fishing unit. The former serves to catch enough gobies to serve as bait for the latter.

The seine.—The seine is among the oldest nets known in the world and consists essentially of a long narrow strip of net with the necessary floats and weights to maintain the upper part of the net at the surface of the water and the lower in close contact with the bottom of the sea. It is usually employed to catch fish on a gradually inclined seashore.

The net is composed of three parts; namely, the two wings and the bunt between them, the latter having a smaller mesh than the former. Throughout the whole length the net may be of uniform depth or narrower at the wings and deeper at the bunt so as to form a pocket or purse. Into this pocket all the fish inclosed by the seine are impounded as the net is being gradually hauled to the shore out of the water. For

anchovies, dilis (Engraulidæ) and young herrings, *siliñasi* (Clupeidæ) the seine may be made of sinamay.

The talacop.—The *talacop* is a purse seine for catching *hasá-hasá* (*Rastrelliger brachysomus* Bleeker) and *alumahan* (*R. chrysozonus* Rüppell). This in principle is different from an ordinary seine in that instead of having a pocket and distinct wings and being operated on a gradually inclined seashore, it is operated in deep water and the whole net is manipulated so as to form a sort of pocket by "pursing" the lead line, thus preventing the escape of the fish through the bottom. Their escape on the surface is made impossible by the head line kept at the surface by the floats. In order that the "pursing" may be easily accomplished rings are placed along the bottom line through which passes a rope that is pulled hurriedly as soon as the school is completely surrounded by the net. Thus, before the fish are able to make their escape the bottom is closed. The net is then hauled in until all the fish are confined to a small area. They are then taken out with a dip net. Many fish are also gilled. This net is about the same in dimensions as the bating. Another, and older, name for the talacop is *cubcub.*

The prawn net.—This is a modification of the seine, but the pocket is much deeper and it is used under water. The weights are proportionately heavier than the buoyancy of the floats, the latter holding the net in a vertical position with the pocket opened. The nets in Manila Bay that would be included under this classification are the *pukot* or *hila-hila,* and the *taksay.* The pukot, or hila-hila, is used in shallow rivers emptying into Manila Bay and where shrimps are caught in large quantities. It is especially common in Tinajeros, a barrio of Bacolor, Pampanga. The pocket is usually about 10 meters long with a mouth 4.5 meters in breadth and a wing on each side of about 2.5 meters or a little less. The depth of the net is 2.5 meters. The mesh is 2.5 centimeters stretched at the mouth, and 1.75 centimeters at the back of the pocket. The end of the pocket has an opening about 0.75 centimeter in diameter, and this is tied to close the pocket when in operation.

Two men are required to operate this gear. It is started from one side of the river and pulled across at an angle to the course of the water, each man pulling a rope holding one end of the gear.

The saklit.—The *saklit* is a small pukot and is operated in small streams. It is about one-half the pukot in all dimensions and no rope is necessary to operate it. The mesh is about 1.5 centimeters stretched at the back of the pocket and about 2 centimeters at the mouth.

The taksay.—The *taksay* is operated in the deeper parts of Manila Bay, and the operators therefore are in a banca. The net is dropped to the bottom and by means of tow ropes at each end, which may be 100 meters long, it is dragged along the bottom of the sea by pulling the ropes into the banca until the net is brought in and the catch collected. Then the net is again thrown into the water and allowed to sink to the bottom, when the operation is repeated.

This net usually has a pocket about 4 meters long and the mouth and wings have about a 20-meter spread. The lower part of the net is usually of hemp. The mesh is about 4 centimeters stretched. Six men usually operate this net from a 12-meter outrigger banca.

The utase.—A similar apparatus operated in Manila Bay, but larger, is the Japanese trawl net, the *utase.* Instead of being dragged along the bottom of the sea by men in a banca, it is attached to a sailboat or launch. The net is dragged along the bottom of the sea for a long distance; that is, for the distance traveled by the boat during all the time of the operation. There are several utase outfits operated in Manila Bay by Japanese, supplying the market with a large quantity of bottom fishes such as *sapsap* (Leiognathidæ), *besugo* (*Nemipterus* spp.), and shrimps. Other species are also caught.

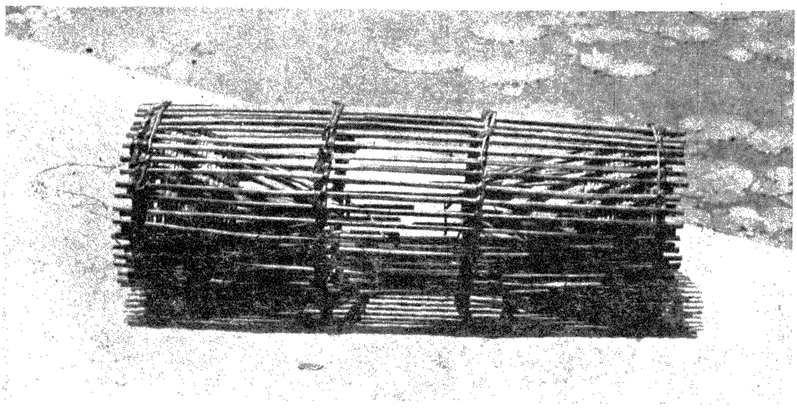
The biacus.—The *biacus* of Pampanga is similar to the diacus but is of fine-meshed cotton net instead of sinamay.

The salambao.—The *salambao* is in fact a bintol, but constructed on a much larger scale. It is suspended from the top of a tower, which may be as high as 15 to 20 meters and which may be moved so as to raise and lower the net in and out of the water in order that the catch may be taken with a dip net. The tower is operated by means of a weighted lever which the fisherman either pulls down or on which he climbs in order to bring up the end of the tower with the net. This gear is seen in most rivers and river mouths. Usually two men work together. It catches few fish at a time but is operated repeatedly every few minutes.

The pantukos.—The *pantukos* is for catching herrings. It is a large square or rectangular net with floats and weights to keep the upper line on the surface of the water and the lower line on the bottom. The corners are attached to ropes that are manipulated from two bancas on each side of the net. By means of noise and torches a number of men in fourteen or fifteen smaller bancas, formed in a line, start from the shore and drive the fish towards the pantukos. As soon as the fish are driven to the net, the sides are raised above the surface of the water, thus imprisoning the fish. The net is then pulled into the banca until the fish are confined in a small pocket from which they are removed by dip nets. This fishing gear was formerly common but is fast becoming obsolete.

The dala.—The *dala,* or casting net, is used most anywhere in the bay. This is a very old net that has been used in all parts of the world since time immemorial, and is therefore a gear well known to most fishermen. It is pyramidal in shape with a heavy string attached to the apex and the basal circumference heavily weighted. With one hand holding the string the fisherman casts the net into the water covering the school sighted. As the leads sink to the bottom, the fish are caught inside the net.

ILLUSTRATIONS



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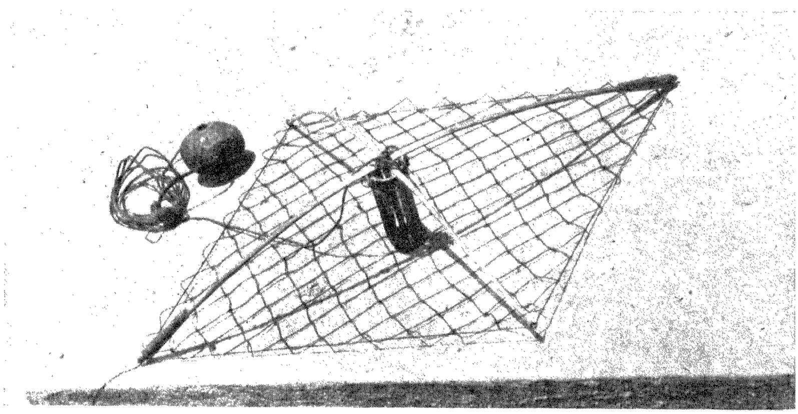

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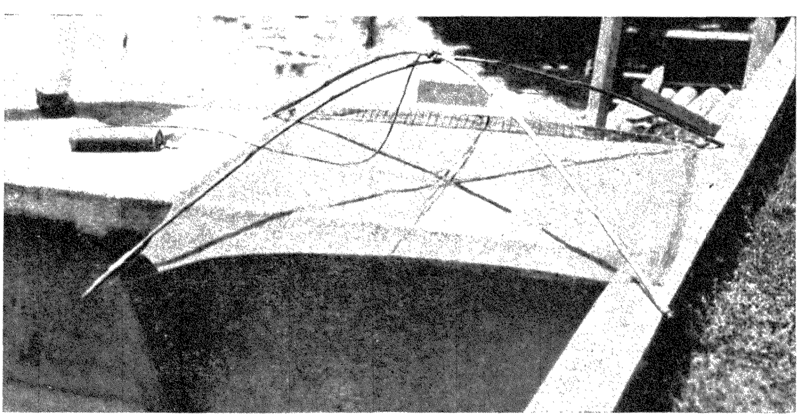

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PLATE 1.

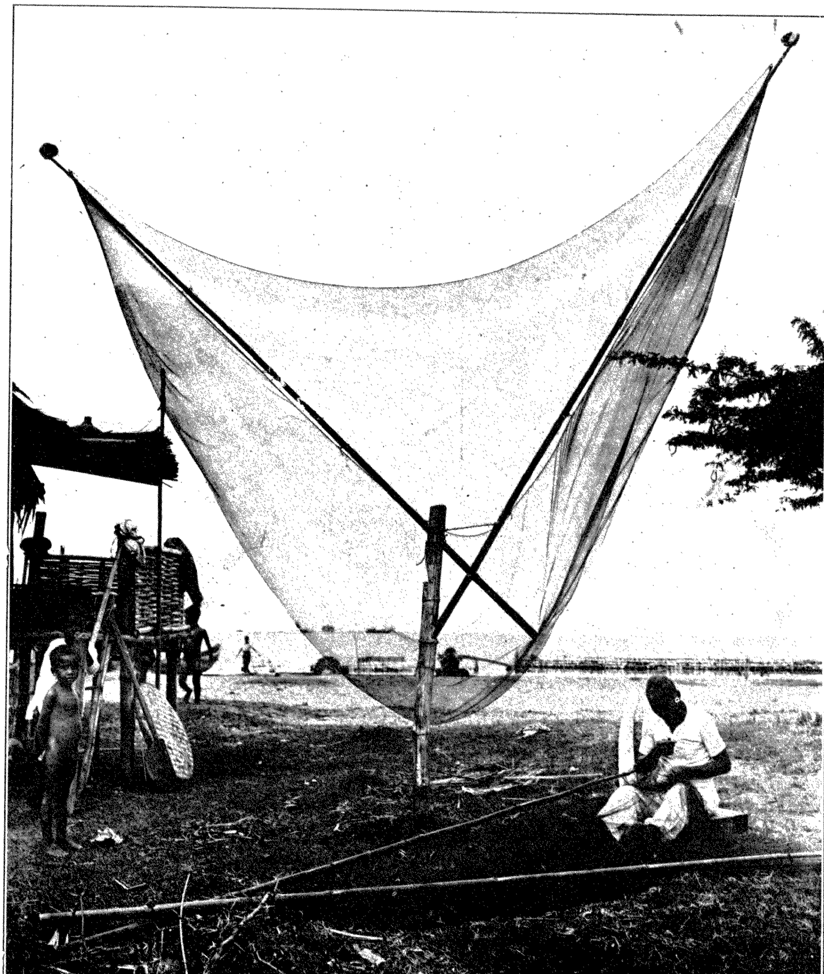

PLATE 2. SAKAG BEING DRIED.

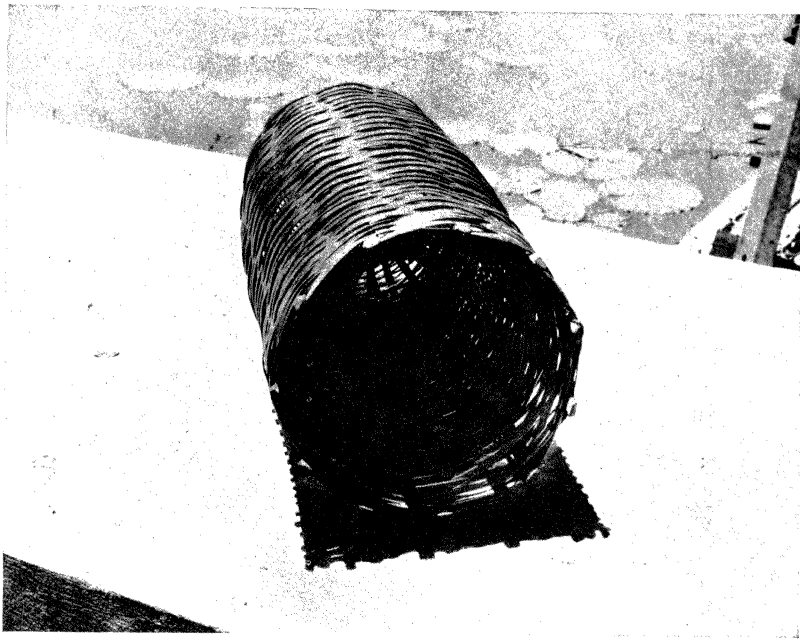

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PLATE 3.

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PLATE 4.

PLATE 5.

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THE PHILIPPINE
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THE NAIL-HOLDING POWER OF THE PRINCIPAL PHILIPPINE COMMERCIAL WOODS [1]

By JOSÉ C. ESPINOSA
Of the Bureau of Science, Manila

TWO PLATES AND ONE TEXT FIGURE

INTRODUCTION

It is common knowledge that it is harder to drive nails into, and harder to pull nails out of, certain species of woods than others. Furthermore, it is a well-known fact among wood carpenters that a denser or heavier wood holds the nail better and more securely than the ordinary softer variety. It is, however, also true that a harder wood cracks more easily than a softer one; the latter, in general, being able to take a larger number of nails than the former without any sign of splitting. This property of certain species of wood to hold nails better than others is of great importance in box making, crating, and framing. Wooden structures are usually fastened by means of nails, and in the absence of a knowledge or even a rough estimate of the comparative nail-holding power of the woods a rule of thumb is generally adopted, obviously without any scientific basis.

In an effort to find a basis of comparison regarding the relative holding power of some of the commercially important species of Philippine woods, specimens were subjected to a pulling test, which for this purpose may be called the direct-pull test. The

[1] This work was done in coöperation with the Bureau of Forestry, Ranger Martin Lagrimas assisting.

device allowed reading of the load for every 0.004 of an inch displacement while the pulling was in progress. A table of comparison was prepared from the average results of the nail-holding power of the species; and taking red lauan, or Philippine mahogany, as a basis, the different species were given their corresponding percentage values.

METHOD OF TEST

The tests were made in the following manner. Air-dry specimens 2 inches by 2 inches by 15 inches were prepared and three 6d wire nails were driven into each, one in the center and one about 3 inches from each end, so that 1.5 inches of the length of the nail was embedded in the wood. Care was taken that no appreciable splitting occurred while the nails were being driven. Nails were driven without special attention as to whether they were tangential or radial with respect to the grain of the wood, since in practice such conditions are present. An average value was computed from all the tests for each species. The nailed specimens were then laid aside in a dry place so that no appreciable amount of rusting might occur and tests were started immediately thereafter. It is evident that rusting would increase the resistance to pull.

The apparatus is set as shown in the illustration, Plate 1, with the specimen, S, in place. The nail puller indicated by the letter P is a steel rod bent at one end with a V-shaped slit, in the same fashion as the nail puller on the ordinary hammer. It carries a micrometer head, M, on a brass sleeve which can be fixed at any place on the puller by means of a set screw. A copper wire is soldered to this sleeve and connected to a buzzer, which in turn is connected to one pole of a dry battery B. C is a brass contact sheet with a wire lead to the other pole. This brass sheet is attached rigidly to the specimen by means of two screws.

The micrometer head M is raised 0.004 inch and the nail gradually pulled until contact is established and the load recorded. Immediately, the micrometer head is again raised 0.004 inch and the load again read when the buzzer sounds, and so on until the nail no longer offers resistance to pull. In this way each progressive load is taken for every 0.004 inch displacement of the nail head with respect to the specimen, up to the maximum load. When a sudden drop in resistance is noted the loads are again taken for every 0.008 inch displacement.

RESULTS OF TEST

A load-displacement graph was made for each species and an average curve was drawn through the points. Text fig. 1 represents the curve for red lauan, *Shorea negrosensis* Foxworthy. The curves for the other species run in a similar fashion; that is, the load increases steeply to a certain limit and then drops abruptly and follows a flatter curve towards the end. Plate 2 is a combined graph of all the species' curves showing the maximum resistance to pull as well as the relative steepness of the increasing loads.

Table 1 shows the species tested, grouped in the order of their maximum resistance to pull.

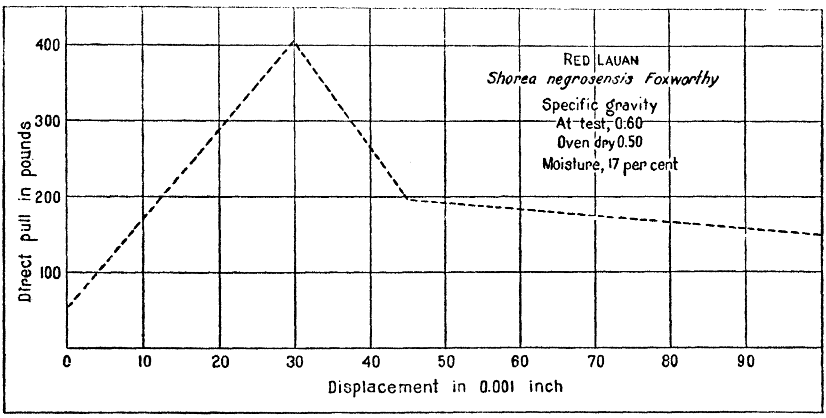

FIG. 1. Graph showing the nail-holding power of red lauan, *Shorea negrosensis* Foxworthy.

In Table 2 the species are arranged in the order of the slope of the curve up to the maximum resistance. The second column gives the value of tan α as shown in the graphs. This third column gives the ratio numbers corresponding to tangent α, the value for red lauan being 100.

DISCUSSION OF RESULTS

A graphical comparison of the nail-holding power of the different species tested (Plate 2) places pagatpat at the head of the list. An examination of the driven nail, however, showed considerable rusting which can be explained by the fact that pagatpat contains a high percentage of common salt, sodium chloride. When using this wood it is the practice to fasten the pieces together with copper or brass nails which are less at-

TABLE 1.—*Species arranged in the order of maximum resistance to direct pull.*

Common name.	Maximum resistance to pull.	Ratio number taking 100 as red lauan value.	Specific gravity.		Moisture content.
			At test.	Oven dry.	
	Lbs.				*P. ct.*
Pagatpat	840	207	0.75	0.64	18
Lamog	760	188	0.90	0.77	17
Manggachapui	745	184	0.79	0.69	15
Supa	680	168	0.79	0.68	16
Akle	655	162	0.69	0.58	19
Narra	650	161	0.65	0.57	14
Akleng parang	647	160	0.71	0.61	16
Molave	635	157	0.81	0.71	15
Amugis	620	153	0.89	0.75	18
Malugai	590	146	0.71	0.61	16
Banuyo	580	143	0.72	0.60	19
Tindalo	575	142	0.86	0.75	14
Pahutan	555	137	0.67	0.57	19
Kalamansanai	550	136	0.83	0.70	18
Aranga	535	132	0.84	0.72	17
Yacal	515	127	0.90	0.77	17
Guijo	510	126	0.80	0.66	21
Tanguile	500	123	0.64	0.55	17
Bayok	485	120	0.58	0.50	17
Amamanit	480	118	0.71	0.61	18
Nato	480	118	0.59	0.50	17
Palosapis	440	109	0.61	0.52	17
Toog	435	107	0.64	0.54	18
Red lauan	405	100	0.60	0.51	17
Benguet pine	400	99	0.73	0.60	21
Batete	343	85	0.60	0.51	19
Almon	313	77	0.70	0.60	16
Kalunti	300	74	0.68	0.58	17
Lumbayao	297	73	0.47	0.40	18
Apitong	285	70	0.73	0.62	17
Mayapis	270	67	0.41	0.34	20

tacked by salt. Pagatpat should, therefore, be treated separately in the discussion.

Lamog, manggachapui, supa, akle, narra, akleng parang, molave, and so forth, follow in the order of maximum resistance to pull. It may be noted that these species are high in oven-dry specific gravity, in the order of 0.57 to 0.75.

Mayapis, apitong, lumbayao, kalunti, almon, batete, Benguet pine, and red lauan have much lower resistance to pull, their oven-dry specific gravity being correspondingly lower, in the order of 0.34 to 0.62.

TABLE 2.—*Species arranged in the order of the slope of the curves up to the maximum resistance as shown in fig. 2.*

Common name.	Tan a.	Ratio number corresponding to tan a.	Specific gravity.		Moisture content.
			At test.	Oven dry.	
					P. ct.
Pagatpat	1.975	167	0.75	0.64	18
Manggachapui	1.904	161	0.79	0.69	15
Aranga	1.865	158	0.84	0.72	17
Molave	1.800	152	0.81	0.71	15
Kalamansanai	1.724	146	0.83	0.70	18
Amamanit	1.686	143	0.71	0.61	18
Batete	1.639	139	0.60	0.51	19
Banuyo	1.582	134	0.72	0.60	19
Akle	1.551	131	0.69	0.58	19
Amugis	1.541	130	0.89	0.75	18
Malugai	1.500	127	0.71	0.61	16
Palosapis	1.500	127	0.61	0.52	17
Tindalo	1.458	123	0.86	0.75	14
Supa	1.448	122	0.79	0.68	16
Narra	1.446	122	0.65	0.57	14
Lamog	1.340	113	0.90	0.77	17
Lumbayao	1.351	114	0.47	0.40	18
Benguet pine	1.321	112	0.73	0.60	21
Nato	1.265	107	0.59	0.50	17
Pahutan	1.247	105	0.67	0.57	19
Bayok	1.243	105	0.58	0.50	17
Akleng parang	1.200	101	0.71	0.61	16
Yacal	1.192	101	0.90	0.77	17
Red lauan	1.183	100	0.60	0.51	17
Tangile	1.183	100	0.64	0.55	17
Toog	1.167	99	0.64	0.54	18
Guijo	1.095	93	0.80	0.66	21
Apitong	1.093	92	0.73	0.62	17
Mayapis	1.048	87	0.41	0.34	20
Almon	0.981	83	0.70	0.60	16
Kalunti	0.850	72	0.68	0.58	17

It may also be noted that while yacal, tindalo, amugis, and aranga have high specific gravities—in the order of 0.72 to 0.77—they do not occupy as high a place as manggachapui, the specific gravity of which is 0.69. It seems that the only possible explanation of this variation is the inherent physical structure of the wood itself. Yacal, for example, is easily split and while splitting may not be discernible to the eye during the tests, it is quite possible that the fibers may have been separated in such a way as to give the low figures characteristic of this phenomenon.

Table 1 gives the species arranged in the order of maximum resistance to pull as shown in the graphs.

Table 2 gives the species arranged in the order of the slope of the curves up to the maximum resistance. There seems to be no definite relation between the slope of a curve and the specific gravity of a given species. In other words, it may take a greater pull to displace the nail a unit distance in the case of a species with low specific gravity than in the case of a species with a higher specific gravity. This fact seems to be contrary to what one may generally believe, but it is obvious that the slope has absolutely no relation to the maximum resistance.

CONCLUSION

The results of the test show that it is safe to assume that the nail-holding power of Philippine woods is closely related to the specific gravity; that is, the denser the wood the higher the nail-holding power.

The amount of displacement due to a unit pull was found to have no relation to the specific gravity.

Among the important species of high nail-holding power special mention may be made of manggachapui, which is already well known for its good qualities as flooring material.

ILLUSTRATIONS

PLATE 1

Apparatus for testing nail-holding power of wood. S, specimen; N, one of the three nails driven in the specimen, the middle nail is under test; M, micrometer head; C, brass contact sheet; P, nail puller; H, testing-machine head support; B, dry batteries and buzzer unit.

PLATE 2

Graph showing load-displacement curves of the species tested.

TEXT FIGURE

FIG. 1. Graph showing the nail-holding power of red lauan, *Shorea negrosensis* Foxworthy.

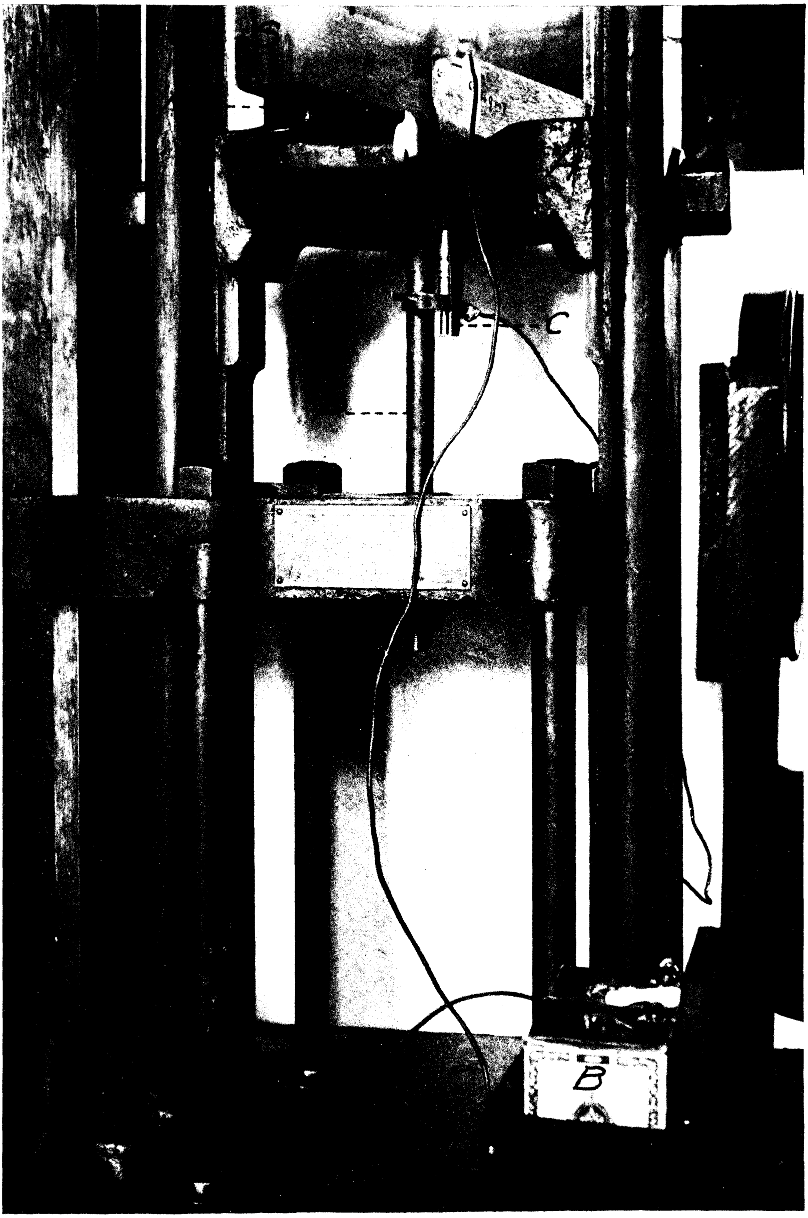

PLATE 1.

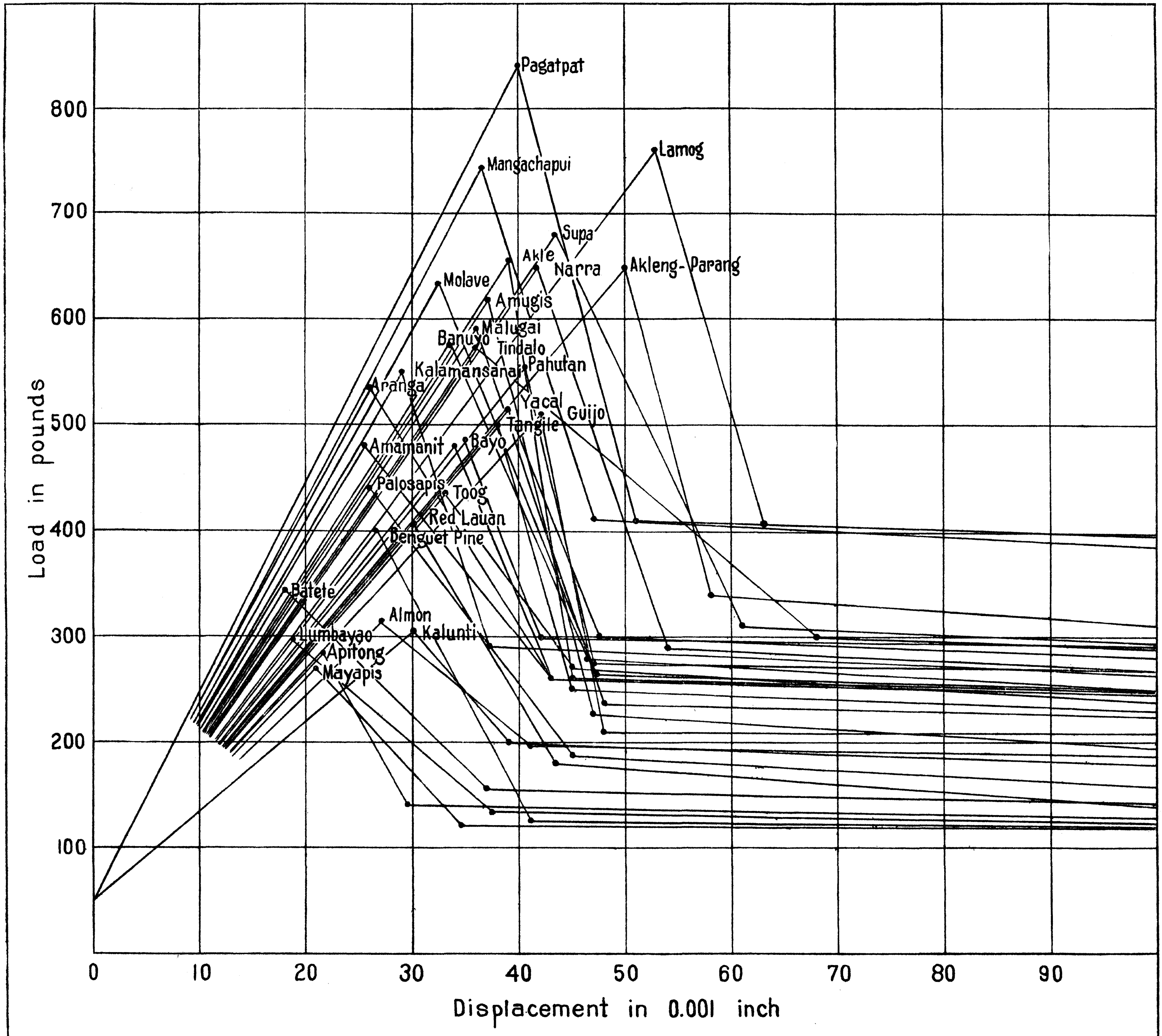

PLATE 2. GRAPH SHOWING LOAD-DISPLACEMENT CURVES OF THE SPECIES TESTED.

ANTIMOSQUITO SPRAYS

By R. L. Holt and J. H. Kintner

Of the United States Army Medical Department Research Board, Manila

The least that can be charged against the mosquito in its contact with higher animals, including man, is that it is a nuisance. In addition thereto, these insects are a serious menace in many parts of the world due to their ability to infect with malaria, dengue, yellow fever, and filariasis. The control of these infections depends on the control of the mosquito population and the prevention of their infection by allowing access to cases and carriers of the diseases mentioned. Everyone knows that the ideal situation would be achieved if mosquito breeding could be completely eliminated with consequent disappearance of these insects from the earth. This has been the dream of many men, but its practical accomplishment is not possible at the present time and one doubts if it ever will be a reality. Since this is true, it behooves us to see to it that breeding in or near human habitation is prevented or curtailed and that infection of mosquitoes is kept at the lowest rate possible, by screening cases or carriers while they are infective. The world over, these factors can be controlled to a limited extent only, due to ignorance, carelessness, indifference, and opposition for opposition's sake. Strangely, we have types of animals in human form who are opposed to anything suggested by the so-called "Medical Trust" for no other reason than that the suggestion comes from a medical source. Such mental cases are hopeless, and our only recourse is to arouse public opinion in such manner as to force their coöperation.

In the Philippine Islands, mosquitoes breed more or less freely at all elevations, particularly below 1,500 feet, and the conditions are such that they breed in profusion in most places. The continual hot climate, the heavy rainfall, and the limited finances of the Government, all help to make mosquitoes more or less of a general nuisance in this Archipelago. *Culex, Aëdes,* and/or *Anopheles* are highly prevalent in many places. As a result malaria and dengue are common and constant companions of thousands of the population. The only reason that yellow fever

is not a scourge comparable to those in Europe in the Middle Ages is that, by chance, no case of yellow fever has been imported into the Islands. In the event that yellow fever ever does come to these shores, it will be a calamity beyond our comprehension.

In Manila the principal infection spread by mosquitoes is dengue and, since the native population is almost, if not completely, immune, its effects are noted exclusively among nonnatives such as tourists, Army and Navy white personnel, and foreigners resident in Manila. Mosquitoes are no less a nuisance to the native than to the foreigner. While the health authorities, both native and American, do what they can to prevent mosquito breeding, what they actually accomplish falls far short of the ideal. Lack of sufficient funds and indifference to or ignorance in sanitary matters are insurmountable difficulties at the present time.

As a result of the nuisance caused by swarms of mosquitoes and the high prevalence of dengue, it was considered well worth while to attempt to develop an efficient spray to destroy the adult mosquito in homes and hospital wards especially.

It is well known that commercial preparations of this sort have a very low degree of efficiency insofar as killing the insect is concerned. They have a certain amount of repelling power. One commercial preparation bearing a well-known name will bring down many of the insects, but they recover from its effects in most cases. Some of them seem to require that the insect be drowned by the liquid. Certainly they have little other effect.

The problem to be solved was to find a preparation which would kill mosquitoes under such conditions that it could be applied practically to large indoor areas, such as hospital wards, and at the same time result in little or no toxic effects on patients. In addition, fire hazards and damage to linens and draperies had to be taken into consideration. Toxicity was determined in all cases by the effect on personnel present and on white mice exposed in the area in which the spray was applied.

The apparatus used was an air compressor driven by an electric motor and developing 60 pounds pressure. This air pressure was applied to a paint-spray apparatus extension to allow the spray to be set loose near the ceiling. The spraying apparatus was adjusted so that it delivered the spray as a fine mist resembling steam. In this manner the entire ceiling of

the room was covered and the spray allowed to "settle out" for one hour. Electric fans were stopped, and if a breeze was present the windows on the side from which it came were closed. Otherwise all windows and doors were left open. The preliminary work was done in a room containing 1,500 cubic feet. Of the 490 square feet of wall area, 50 square feet was taken up by windows which were simply openings in the wall covered by screening. The room was made mosquito proof by the use of 20-mesh netting. The floor was covered with white paper to facilitate collection of the dead insects.

The first mixture tried had the following formula:

Oil of eucalyptus	9
Methyl salicylate (synthetic)	18
Oil of citronella	50
Kerosene (purest quality) q. s.	1,000

One hundred *Aëdes ægypti* were liberated and a five-minute period allowed for them to disperse. Five hundred cubic centimeters of the mixture was sprayed near the ceiling, care being exercised to prevent the spray coming in contact with the insects as it emerged from the spray nozzle. This 1 cubic centimeter for each 3 cubic feet produced a fairly heavy mist in the room, which cleared slowly by falling to the floor and passing through the open windows. Both men and mice suffered moderate toxic effects. At the end of one hour twelve insects were picked up and at the end of the second hour four additional ones were collected. At the third hour no insects were found. Two of the sixteen recovered in twenty-four hours. The efficiency of this mixture in toxic concentration can be rated at only about 14 per cent.

The second formula tried was as follows:

Carbon tetrachloride	12.5
Methyl salicylate (synthetic)	25
Naphthaline	30
Kerosene, q. s.	1,000

Exactly the same conditions prevailed as in the previous experiment. Fifty cubic centimeters of the spray, or 1 cubic centimeter for each 30 cubic feet of air space, was liberated when toxic symptoms were noted both in the personnel applying the spray and in the control animals. In this concentration nine insects were collected the first hour and four the second. None recovered in twenty-four hours. The efficiency can be rated at about 13 per cent in toxic concentration.

The third mixture was as follows:

Methyl salicylate (synthetic)	25
Pyrethrum powdered (fresh)	60
Kerosene, q. s.	1,000

This mixture of pyrethrum and kerosene was shaken frequently over a period of two hours and filtered. To the filtrate was added the methyl salicylate. Under the same conditions described heretofore 1 cubic centimeter for each 30 cubic feet was sprayed into the room. At the end of the first hour seventeen insects were collected, and at the end of the second hour twelve. No toxic effects were noted. None of the insects recovered in twenty-four hours. The efficiency of this preparation is about 29 per cent under the conditions noted.

The fourth mixture was as follows:

Carbon tetrachloride	12.5
Methyl salicylate (synthetic)	25
Pyrethrum powdered (fresh)	60
Kerosene, q. s.	1,000

The first two ingredients were added to the filtrate after the pyrethrum had been extracted for two hours in the kerosene and filtered. One cubic centimeter of the mixture was used for each 30 cubic feet of air space. At the end of the first hour nineteen insects were picked up, and five additional ones were collected the second hour. No insect recovered in twenty-four hours. Efficiency rate about 24 per cent. Toxic effects slight.

Since we were convinced that most of the lethal effect of these sprays was due to pyrethrum, the task of finding a better solvent for the active principle or principles was undertaken.

Carbon disulphide and acetone were tried as solvents.

One hundred twenty cubic centimeters of carbon disulphide were added to 60 grams of pyrethrum powder and extraction continued for two hours. The mixture was shaken frequently during this time. The filtrate was added to sufficient kerosene to make the mixture up to 1,000 cubic centimeters. A preparation was made in the same manner using acetone instead of carbon disulphide. The filtrate from each of the above extractions amounted to about 40 cubic centimeters.

When these preparations were tried it was found that the carbon disulphide was toxic in concentrations of 1 cubic centimeter for each 85 cubic feet of air space, the mice showing much distress. One of them was unable to rise from the floor of the cage. The efficiency of this preparation was 95 per cent, ninety-

five of the hundred mosquitoes dying within one hour. The odor of this mixture was very objectionable.

The acetone spray proved to be toxic in concentration of 1 cubic centimeter for each 72 cubic feet of air space, the personnel suffering from nausea, headache, and dizziness. The mice showed every evidence of toxicity. The efficiency of the spray in this concentration was 100 per cent in the first hour.

A further objection to both the acetone and carbon disulphide mixtures is the danger of fires and explosions from matches, cigarettes, and sparking electrical installations. The toxicity alone would have condemned it since the use for which it was intended contemplated the presence of patients in the wards during the use of the spray.

It was found that the chloroform extract had none of the objections mentioned above. Concentrations up to 1 cubic centimeter for each 10 cubic feet of air space showed no toxic effects on small animals or man.

After 60 grams of powdered pyrethrum had been treated with 120 cubic centimeters of chloroform for two hours with frequent shaking, it was filtered through a Buchner funnel, the filtrate averaging about 50 cubic centimeters. The filtrate was made up to 1,000 cubic centimeters with kerosene.

Preliminary laboratory trials having shown that the efficiency of this preparation approached that of acetone and carbon disulphide extracts and that visible evidences of toxicity were absent in effective concentrations, it was decided that a trial would be made on a large scale. The ward selected was 15 feet high, 40 feet wide, and 164 feet 8 inches long, having a cubic content of 98,800 feet. The wall space measured 6,140 square feet. Of this area 1,115 square feet were represented by twenty-seven windows and four doors, all of which were simply spaces in the wall covered by screen wire or screen doors. No attempt was made to close any of them. All fans were stopped. Three thousand seven hundred fifty cubic centimeters of the chloroform-extract spray was liberated in the form of a fine mist and distributed evenly over the ward near the ceiling. This represented 1 cubic centimeter of the spray for each 26+ cubic feet of air space. Forty-three patients were present in the ward during the spraying and for twelve hours afterward.

Immediately after the spraying had been completed, a 20-mesh mosquito-netting cage, 20 by 12 by 12 inches, and containing one hundred *Aëdes* mosquitoes, was brought in and placed

on the floor near the center of the ward. At the end of thirty minutes ninety of the insects were on the floor of the cage. Three others were overcome during the night. No recoveries were noted in the subsequent twenty-four hours.

No complaints were registered by any of the patients in the ward, but on the other hand several stated that it was the first time they had not been annoyed by mosquitoes since they had been in the ward.

Several flies and cockroaches were found dead on the morning following the use of the spray. Later experience shows cockroaches and house ants as very susceptible to the action of this mixture.

To further prove the worth of the spray other wards of approximately the same size were treated in the same way. In the first of these, the concentration was 1 cubic centimeter to 21.4 cubic feet and in the second 1 cubic centimeter to 30.8 cubic feet. Efficiency was 93 per cent in the first and 87 per cent in the second.

One other ward was treated with straight chloroform in kerosene in the same quantity as that used to extract the pyrethrum. This showed an effectiveness of only 3 per cent. This number of insects might have died naturally during the night, although in all cases where these insects were used, food and water were kept constantly in the cages.

COMMENT

What seems to be a highly efficient and nontoxic spray is described. Experience with this and other mixtures with results obtained are related.

THE CONTROL OF ANOPHELES MINIMUS MOSQUITO LARVÆ IN THE PHILIPPINES BY STRANDING AND FLUSHING [1]

FIRST REPORT

By PAUL F. RUSSELL

Of the International Health Division of the Rockefeller Foundation

ONE PLATE AND ONE TEXT FIGURE

INTRODUCTION

It has long been known that in those parts of the Philippine Islands where there are distinct wet and dry seasons, the incidence of acute malaria is always less during the period of heavy rains—that is, from about July to November—than in the dry months from January to June. Lay testimony in the foothill districts is that the prevalence of "mosquitoes" is always reduced in the wet season.

It is well established that the principal vector of malaria in the Philippines is *Anopheles minimus*. The only other species under suspicion is *A. maculatus*, which Manalang (1) has recently found infected in nature. The larvæ of these two species of mosquitoes are most often found in the small streams of the foothills; and it is in this foothill zone, below 500 meters' altitude, that malaria is most prevalent and most severe.

Therefore, it has been assumed that the flushing of these foothill streams is a natural means of curtailing the incidence of malaria during the "typhoon season" of torrential rains, by its direct effect on the larvæ of *A. minimus*. There has been some proof of this assumption in the reports of the staff of malaria investigations who, after very heavy rains, have failed to find larvæ in routine examinations of such streams.

[1] These studies were made as a part of the program of malaria investigations, of which the author is chief, which are under the joint auspices of the Bureau of Science, Manila, and the International Health Division of the Rockefeller Foundation. Mr. D. Santiago, a field inspector of malaria investigations, assisted by making the collections reported in this experiment.

Mieldazis[2] noted this and in an experiment in 1929 attempted to make practical use of the phenomenon by discontinuing all control work in a selected area during the rainy season. This did not prove feasible as there were sharp outbreaks of malaria following cessation of control. It would appear that the natural flushing during the period of the experiment was irregular and sometimes widely spaced.

Bently[3] in Bombay and others have advocated flushing as a method of mosquito control. In fact, according to Hehir,[4] flushing has been an occasional public-health procedure since Empedocles flooded the lowlands surrounding Selinos, in ancient Greece, and thus made a pestilential city healthy. But in these cases the flushing has been more a flooding than a true flushing. In some cases, for example, it has made a lake of a marsh or of a stream. The present paper deals not with flooding in this sense, but rather with a scouring action on the larvæ below the dam and a stranding of larvæ above it.

PROCEDURE

In view of the apparent but unproved natural reduction of malaria in regions of the Philippine Islands by flushing action of heavy rainfall on the stream breeding places of *A. minimus*, the chief vector of malaria, it was determined to make some quantitative tests of the inhibitory effect of flushing on *Anopheles* larvæ in a stream which lent unusual opportunity for such a study.

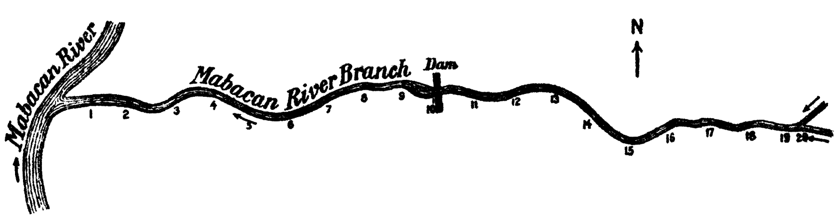

FIG. 1. Branch of Mabacan River, near Calauan, Laguna Province, Luzon, showing location of dams and stations.

Through the generous coöperation of the Calauan Sugar Hacienda, Laguna Province, a small stream in Mabacan was put at our disposal (fig. 1). This branch of Mabacan River is a shallow, tortuous, clear, flowing stream, some parts with grassy banks, other sections fairly well shaded by overhanging bamboos and jungle growth. It is what is called in the Philippines a typical *A. minimus* breeding place, and has shown very large

numbers of larvæ. From its source, which is the junction of two smaller streams, to Mabacan River it is about 400 meters long. It has a normal depth varying from 15 to 50 centimeters. In width it varies from 1 to 2 meters, approximately. Almost at the mid-point between its source and outlet there is a cement dam which when closed permits the backing up of water to a level 115 centimeters above that of the stream when the dam is open. Closing is accomplished by blocking a round hole 50 centimeters in diameter (Plate 1).

In order first to determine the normal conditions of this stream, weekly collections were made from April 7 to May 19 below the dam and from the latter date until June 2 both above and below the dam. Each collection was made by dipping 80 times along the banks for larvæ. At all times *A. minimus* predominated by more than 90 per cent. Occasional larvæ of the following species were taken: *Anopheles filipinæ, A. vagus, A. barbirostris, A. maculatus,* and *A. fuliginosus.* The total catch of larvæ is shown in Table 1.

On June 8 the dam was closed at 5.52 a. m., had filled to its top, 115 centimeters from the bottom, at 8.56, and was opened at 9.10 a. m. Above the dam the depth of the stream had gradually changed from the normal of 15 to 50 centimeters to one varying from 115 centimeters near the dam to about 50 centimeters at the source. Below the dam the depth had gradually decreased to almost nil at the dam and not over 10 centimeters at the outlet where the influence of Mabacan River prevented any lower depth.

Upon opening the dam the water rushed out with considerable force, requiring about twenty-five minutes to resume its usual levels.

On June 9 the same dipping procedure, which had in previous weeks revealed some hundreds of larvæ, now resulted in a catch of 98 larvæ above and 41 below the dam—a marked reduction.

The following week larvæ were again present in their usual abundance, as recorded in the table.

On June 22 almost the same procedure was followed as on the 8th. An additional 30 centimeters' height of water behind the dam was secured by adding a board to the top. The dam was closed at 7.50 a. m., had filled to 135 centimeters' height by 2.00 p. m. and was opened at 2.27 p. m. It required about thirty minutes to empty.

TABLE 1.—*Anopheles larvæ dipped from branch of Mabacan River during an experiment with damming and flushing.*

Date.	Number of larvæ. Above dam.	Below dam.	Remarks.
April 7	--------	394	Eighty dips.
April 11	--------	--------	Water raised 30 cm by casual obstruction at dam, suddenly released.
April 14	--------	192	Eighty dips.
April 21	--------	606	Do.
May 2	--------	--------	Water raised 60 cm by casual obstruction at dam, suddenly released.
May 5	--------	54	Eighty dips.
May 12	--------	132	Do.
May 19	--------	313	Do.
May 26	695	935	Do.
June 2	552	828	Do.
June 8	--------	--------	Dam purposely closed. Water level raised 115 cm, then released with moderate speed.
June 9	98	41	Eighty dips.
June 16	461	645	Do.
June 22	--------	--------	Dam purposely closed. Water level raised 135 cm, then released with moderate speed.
June 23	53	52	Ten stations, 80 dips.
July 6	--------	--------	Dam purposely closed. Water level raised 115 cm, then released with moderate speed. This procedure then repeated.
July 7	16	20	
July 14	222	862	
July 20	--------	--------	Dam purposely closed. Water level raised 115 cm, then released with moderate speed. This procedure then repeated.
July 21	13	23	
July 26	236	554	
July 27	--------	--------	Dam purposely closed. Water level raised 115 cm, then released with moderate speed. This procedure then repeated.
July 28	6	27	
			During the entire period of this experiment there were no heavy rains, the onset of the usual wet season having been delayed until August. Small larvæ included in the counting.

On June 23, as on June 9, the catch of larvæ was much smaller than usual (see Table 1).

On July 6, the procedure followed on June 8 was again employed, but this time it was repeated as soon as the water had emptied. In other words, there was a double flushing, the whole operation requiring about eight hours.

On July 7, the next day, relatively few larvæ were found. These larvæ and all subsequent catches in the experiment were not retained but were returned to the stream. As noted in the table, beginning on June 23 there were established ten definite dipping stations above and ten below the dam. These were

spaced at regular intervals, and all dipping was done at these places, identified by special markers.

By July 14 conditions were normal again. Another double flushing on July 20 resulted again in a strongly marked reduction in larvæ both above and below the dam.

On July 26 catches were normal, on July 27 a double flushing was done, and on July 28 the catches were almost nil.

During all of this period, from April 7 to July 28, there were no heavy rainfalls, the normally rainy July weather being absent. On August 7 the first typhoon signals of the season were displayed and two weeks of torrential rains introduced tardily the 1931 rainy season. This preliminary experiment was therefore brought to a close, although the stream remains under observation for further reports. (It may be noted that on August 18 the stream when dipped from source to outlet did not reveal a single larva. This was after very heavy rains.)

It is of interest that the effects of the dam in this experiment were as great above it as below. Below, the larvæ were destroyed or removed by the flushing action. Many must have been drowned by the turbulence of the waters released from the dam. It is known that wave action will, unless too gentle, destroy larvæ. For example, refer to Kibbey(5) who reported the control of breeding by using a power launch to patrol the shores of a lake. The boat created waves that splashed ashore and killed all larvæ. Practically 100 per cent control was obtained without the use of larvicides.

Above the dam the effect was probably one of stranding in the grasses and other vegetation, for the tendency of the larvæ was to stay at the edges as the water rose to higher levels. The fairly rapid fall must have left many of them out of water. Some probably were caught in the unusual current and perished below the dam. Observations on the effect of this procedure on malaria incidence will be reported later.

Much more study is needed but these first observations are convincing as to the potential usefulness of this simple and inexpensive method of destroying *A. minimus* larvæ, a procedure which imitates to some extent a natural malaria deterrent in the Philippine Islands.

DISCUSSION

Malaria in the Philippines can be largely obviated by attacking the *Anopheles minimus* mosquito. Whether *A. ludlowi* in the southernmost islands of the Archipelago will carry malaria

naturally, remains to be determined. The so-called *A. ludlowi* of Luzon is not a vector in nature.

There is no alternative method to that of larva control of *A. minimus* in fighting malaria in these Islands at present. The problem is simplified by the fact that this Philippine vector, as well as the recently convicted *A. maculatus*, breeds almost exclusively in the small streams of the foothills. Mountains and marshes, lakes and rice fields, stagnant waters generally, may all safely be ignored in the attempt to control malaria, according to present knowledge. The irrigation ditches of cane fields are sometimes attractive to *A. minimus* but not often.

It has been well demonstrated by Tiedeman(6) and Mieldazis(2) and by the United States Army Medical Corps at Fort Stotsenburg(7, 8) that the use of Paris green, distributed in the usual way, offers a method par excellence for the control of *A. minimus* breeding. There can be no doubt about this whatever in the light of the results obtained.

However, the situation is seriously complicated by cost of supervision and lack of funds. This is growing worse, with a small budget (75,000 pesos) about to become smaller by reason of the local effects of the present world-wide financial depression.

For these reasons the staff of malaria investigations is trying to find ways and means of reducing the cost and of minimizing the labor factor of malaria control.

The results of this preliminary experiment, in flushing and stranding *A. minimus* larvæ out of a stream, are, therefore, presented in the hope that in some places it may be possible by this means alone so to reduce the incidence of the *A. minimus* mosquito that it will not be at or above that critical number necessary to make it an effective vector of malaria. It is known from the studies of Ross(9) that it is not essential to destroy every last malaria-carrying mosquito to control malaria. Complete eradication, although occasionally feasible, is usually too costly a procedure.

Not every stream by any means will lend itself to this treatment, but many should. It is of special interest that the dam may be located near the mid-point of the length of the stream. This permits more rapid operation and obviates flooding a large area.

Further experiments are in progress not only in this type of control but also in such matters as the automatic distribution of Paris green and the preparation of a cheaper larvicide; all to the end that the incidence of *A. minimus* mosquitoes may be

reduced. Quinine and plasmochin have their place in the attack on malaria in the Philippines, but there would seem to be no real hope of success unless the chief emphasis is along the lines of mosquito control as first advised by Ross(10) many years ago.

SUMMARY

An experiment is reported in which an attempt was made to control *A. minimus* mosquito breeding in a small stream by periodically closing and opening a dam situated about halfway along the length of the stream. Quantitative observations show that this simple procedure done twice on one day a week brought about a marked reduction in larvæ both above and below the dam, probably by stranding above and by flushing below. It is suggested on the basis of this first experiment that such a simple and inexpensive method may be useful in controlling malaria in some areas in the Philippines.

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ILLUSTRATIONS

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PLATE 1.

BLOOD GROUPS IN PHILIPPINE MONKEYS

By HAYASHI HIRANO[1]

Of the Division of Biology and Serum Laboratory
Bureau of Science, Manila

INTRODUCTION

References in the literature concerning blood groups in monkeys are few. Troisier[2] reported that the blood corpuscles of the chimpanzee are agglutinated by human sera of the anti-A and anti-AB group and that the serum of this animal agglutinates human corpuscles of the B and AB type. Therefore, the blood of the chimpanzee has the characteristics of the human blood group A.

Thompson and Tage[3] published the results of their study concerning the blood grouping of the Pavian and the Macaccus. These animals apparently have the group specific receptors for human anti-B, but as regards the receptors for human anti-A the results were not conclusive. The sera of these animals, with two exceptions, contained human anti-A agglutinins.

Landsteiner and Miller[4] examined blood of anthropoid apes and concluded that "The isoagglutinogens of the anthropoids were found to be identical with those of human blood. These very same factors could not be demonstrated in the blood of the lower monkeys."

The results of investigations previous to ours show that there exists a relation between the blood of monkeys and the human types but that there are no blood groups among monkeys themselves.

The present communication gives the results of study concerning the relation between the blood of the Philippine monkey (*Cynomolgus philippinensis* Geoff.) and the human types.

[1] Lieutenant Colonel, Imperial Japanese Army.
[2] Ann. Inst. Pasteur 42 (1928) 363.
[3] Lancet 2 (1919) 675.
[4] Journ. Exp. Med. 42 (1925) 862.

MATERIAL AND TECHNIC EMPLOYED

HUMAN BLOOD

The samples of human blood were either taken outside and received as such or were taken at the laboratory from patients who reported for serologic examination.

The human sera were inactivated by exposure to 56° C. for thirty minutes on a water bath.

For the slide method defibrinated suspension of corpuscles was used, but in the quantitative test the red corpuscles were suspended in physiological salt solution in 5 per cent suspension. In performing the absorption test the suspension, or red corpuscles, was centrifuged for five minutes at a speed of 1,600 revolutions per minute.

MONKEY BLOOD

The samples of monkey blood were obtained by cardiopuncture and both the sera and the red corpuscles were treated in the same way as described under human blood.

TYPE SERA

The human-type sera used in our study were kindly supplied by the United States Army Medical Department Research Board. Standard human corpuscles of the groups A and B were determined each day with blood determined by standard type sera.

THE AGGLUTINATION TEST

The slide method.—For the grouping of human blood the slide method was used as follows: One loopful of each human-type serum A (anti-B) and B (anti-A) was placed separately on a slide and mixed with one loopful of the blood examined and then allowed to agglutinate at room temperature for about five minutes. During this time the blood sera mixtures were rocked back and forth.

Agglutination test in test tubes.—In order to find out the agglutinin titer of human and monkey serum the sera were used in dilution from 1:1 to 1:80, sometimes as high as 1:620. The dilutent used was physiologic salt solution and each test tube contained 0.5 cubic centimeter of diluted serum and 0.1 cubic centimeter of 5 per cent suspension of red blood corpuscles. These mixtures were allowed to agglutinate at room temperature (29° C. to 31° C.) and were shaken several times at intervals of from ten to fifteen minutes before the results were recorded.

The absorption method.—The sera to be absorbed were diluted from 1: 5 to 1: 10 with physiologic salt solution and to 3 cubic centimeters of these diluted sera, 0.1 cubic centimeter of red-cell sediment was added. This sediment was obtained by centrifuging for five minutes at the speed of 1,900 revolutions per minute, and allowed to absorb fifteen minutes at room temperature (29° C. to 31° C.). In the beginning of our work, we allowed the mixtures of sera and red cells to stand one hour at 37° C. in the incubator, but it was found that five minutes at room temperature followed by centrifuging was sufficient. The supernatant translucent diluted serum was pipetted off and used for quantitative agglutination test as already stated by the agglutination test in test tubes.

Recording.—Recording of the results obtained by the slide method was done within five minutes at room temperature (from 29° C. to 31° C.) because the agglutination by this method always occurred sooner and was clearer than by the test performed in test tubes. The results of agglutination were decided by the naked eye, but in case of doubt the microscope was used. Recording of the results obtained by the agglutination and saturation test in test tubes was done within two hours at room temperature (from 29° C. to 31° C.).

DETERMINATION OF BLOOD GROUPS IN HUMAN BLOOD SPECIMENS

In the course of examination of human blood and that of monkeys considerable information has been gathered with regard to the blood-group distribution among the population of Manila and vicinity. This may be of interest to mention.

From October 13 to December 19, 1930, 572 specimens were examined, and the results of the blood grouping by serologic reactions are presented in Table 1.

TABLE 1.—*Results of blood grouping by serologic reactions.*

Human blood group.	Number of specimens.	Percentage.
O	233	40.7
A	154	26.9
B	159	27.8
AB	26	4.5
Total	572	--------

The specimens belonging to group O were the most numerous. The specimens belonging to group A or B were equally represented, while those of group AB were the fewest.

The biochemic index of Manila's population was found to be 0.97. The specimens examined by us were taken from people who live in Manila and vicinity; therefore, a certain small portion of the specimens originated from other races than the Filipino, although the vast majority of these blood samples were taken from Filipinos. In as much as groups A and B are represented in equal proportions, the distribution of groups A and B among Filipinos is that of the intermediate type.

The biochemic index of Filipinos is Asio-African, because the European type shows an index higher than 2.0 and the Asio-African less than 1.3.

For the convenience of the reader the following distribution of blood groups in the three types, that is the European, the intermediate, and the Asio-African, is inserted.[5]

TABLE 2.—*Distribution of blood groups.*

Nationality.	A	B	Biochemical index.	Type.
English	46, 4	10, 2	4, 5	European.
French	45, 6	14, 2	3, 2	Do.
Italian	41, 8	14, 8	2, 8	Do.
German	48	17	2, 8	Do.
Austrian	48	18	2, 6	Do.
Bulgarian	46, 4	20, 2	2, 6	Do.
Serbian	45, 6	20, 2	2, 5	Do.
Greek	46, 8	20, 4	2, 5	Do.
Arab	37, 4	24	1, 5	Intermediate.
Turk	44, 6	25, 2	1, 8	Do.
Russian	32, 5	28, 1	1, 3	Do.
Jew	38	28, 2	1, 3	Do.
Malagasy	30, 7	28, 2	1, 09	Asio-African.
Negro	27, 6	34, 2	0, 8	Do.
Annamese	29, 6	35, 6	0, 8	Do.
Indian	27, 9	49	0, 5	Do.

EXPERIMENTS

In Table 3 are arranged the results of cross agglutination tests performed with the 572 human blood samples and monkey blood. The groups of these human blood specimens were determined and the sera as well as the red corpuscles were used for cross agglutination with the monkey serum and monkey red corpuscles, respectively. The slide method was applied.

[5] Lancet 2 (1919) 675.

It can be seen from this table that none of the human corpuscles belonging to the groups O and B were agglutinated by monkey serum. On the other hand, blood corpuscles belonging to groups A and AB were agglutinated by monkey serum. As to the agglutinability of monkey red cells by human sera, the results show that some human sera, irrespective of group, agglutinated monkey red cells.

TABLE 3.—*Showing the results of agglutination tests performed with human and monkey red cells and human and monkey sera.*

[Slide method.]

Date of test.	Human blood specimens arranged by groups.				Numbers of human blood specimens agglutinated by monkey serum arranged by groups.				Numbers of human sera which agglutinated monkey red cells.			
	Group AB.	Group A.	Group B.	Group O.	Group AB.	Group A.	Group B.	Group O.	Anti-O.	Anti-B.	Anti-A.	Anti-AB.
X-13	0	9	4	6	0	9	0	0	-----	-----	-----	-----
X-14	1	2	4	17	1	2	0	0	0	0	1	5
X-15	0	5	1	8	-----	4	0	0	-----	0	0	0
X-17	1	4	1	6	-----	4	0	0	0	0	0	0
X-20	2	6	2	9	-----	5	0	0	1	3	2	3
X-22	4	3	3	7	4	2	0	0	2	1	2	3
X-24	2	6	4	6	-----	2	0	0	1	2	3	2
X-27	2	10	8	3	-----	8	0	0	0	2	4	0
X-29	1	5	2	11	1	5	0	0	-----	1	2	4
X-31	1	1	6	6	1	1	0	0	0	1	3	6
XI-3	0	3	6	4	-----	1	0	0	-----	1	0	0
XI-5	0	4	8	8	-----	4	0	0	-----	1	3	6
XI-7	0	4	10	2	-----	4	0	0	-----	3	1	2
XI-10	0	9	4	5	-----	7	0	0	-----	4	0	2
XI-12	3	8	16	21	-----	5	0	0	1	0	4	10
XI-14	1	7	5	11	1	7	0	0	0	0	2	5
XI-17	0	5	2	10	-----	3	0	0	-----	1	1	5
XI-19	0	6	10	6	-----	4	0	0	-----	2	5	5
XI-21	0	5	7	5	-----	5	0	0	-----	3	5	2
XI-24	1	5	5	12	-----	3	0	0	1	0	3	7
XI-26	0	5	4	9	-----	3	0	0	-----	3	2	7
XI-28	0	2	3	3	-----	1	0	0	-----	1	1	2
XII-2	0	7	7	2	-----	7	0	0	-----	6	5	2
XII-3	1	3	4	10	1	3	0	0	1	2	2	7
XII-5	3	9	10	9	1	7	0	0	1	6	8	4
XII-8	1	6	12	17	1	4	0	0	0	0	5	7
XII-12	0	6	4	5	-----	3	0	0	-----	1	2	2
XII-16	1	7	4	14	-----	5	0	0	1	4	3	7
XII-19	1	2	3	1	-----	2	0	0	0	1	3	0
Total	26	154	159	233	11	120	0	0	9	49	72	105

The procedure of tests performed daily is evident from Table 4.

In Tables 5 and 6 the results of the agglutination test are given, which show quantitatively the agglutination by human blood serum of group A, of monkey red corpuscles and vice versa. The agglutination test included control groups B and O. This experiment was undertaken to confirm the findings obtained by the slide method as given in Table 3 which showed that none of the corpuscles of the two groups O and B were agglutinated by monkey serum and only those corpuscles that contained the element A were agglutinated. In Table 5 it is shown that distinct agglutination of group A red cells was obtained up to the dilution of 1 to 160 and in some instances as high as 640. The absence in monkey serum of agglutinins for human red cells of the groups O and B is evident from the results obtained with the controls.

In Tables 7 and 8 are recorded human sera that were tested with regard to agglutinins toward monkey red cells. The human sera belonged to various groups as indicated in the tables. The results show that some human sera agglutinate monkey red cells while others do not. The agglutinins in human sera toward

TABLE 4.—*Showing an example of daily examinations concerning types of human and monkey blood (October 22, 1930).*

Blood No.	Human test sera.		Human standard corpuscles.		Results of grouping.	Monkey sera.			Monkey corpuscles.	
	A (anti-B)	B (anti-A)	A	B		A-8	J-18	Z-1	A-8	Z-1
1	+	+	—	—	AB	+	+	+	—	—
2	—	—	+	+	O	—	—	—	—	—
3	....	....	+	—	B	....	....	....	—	+
4	—	—	+	+	O	—	—	—	—	—
5	—	—	+	+	O	—	—	—	—	+
6	—	—	+	+	O	—	—	—	—	—
7	—	+	—	+	A	+	+	+	+	+
8	+	—	+	—	B	—	—	—	—	—
9	+	—	+	—	B	—	—	—	—	+
10	+	+	—	—	AB	+	+	+	+	+
11	....	....	....	....	....	....	....	....	....	....
12	—	—	+	+	O	—	—	—	+	+
13	—	—	+	+	O	—	—	—	—	—
14	—	+	—	+	A	+	+	+	—	—
15	—	—	+	+	O	—	—	—	—	—
16	+	+	—	—	AB	+	+	+	+	+
17	+	+	—	—	AB	+	+	+	—	—
18	....	....	—	+	A	....	....	....	—	—

monkey red cells have no relation to the blood groups to which the sera belong.

Thus far it is clear that the monkey serum appears to have a definite relation to the human groups in as much as it behaves towards human corpuscles just the same as human serum of group B does, but monkey corpuscles behave irregularly in their agglutinability by human sera. This finding casts a shade of doubt on the identity of the agglutinins contained in the monkey serum with the agglutinin of human sera of group B.

TABLE 5.—*Showing the results of agglutination test performed with monkey serum and several samples of human red cells group A. As controls, human red cells group B and group O were used.*

[Test-tube method.]

Human red cells.	Monkey serum.					
	1/1	1/20	1/40	1/80	1/160	1/320
Group A	+++	+++	+++	+++	+	—
Do	+++	+++	+++	+++	++	+
Do	+++	+++	+++	++	++	+
Do	+++	+++	+++	+++	+	+
Do	+++	+++	+++	+++	++	++
Group B	—	—	—	—	—	—
Group O	—	—	—	—	—	—
Do	—	—	—	—	—	—

TABLE 6.—*Showing the results of agglutination test performed with several monkey sera and human red corpuscles, group A.*

[Test-tube method.]

Monkey serum dilution.	Human red corpuscles group A.					
	1/20	1/40	1/80	1/160	1/320	1/640
f-2	+++	+++	++	++	+	—
K-26	+++	+++	++	++	—	—
M-No. 1	+++	+++	+++	+++	++	+
K-28	+++	+++	++	+	—	—
Z-1	+++	+++	++	+	—	—
T-16	+++	+++	++	+	—	—
f-1	+++	+++	++	++	—	—
Int No. 2	+++	+++	+++	+++	+++	--------
Le-No. 2	+++	+++	++	+	+	--------
W-18	+++	+++	++	++	+	--------
Sy-25	+++	+++	++	+	—	—
J-15	+++	++	+	—	—	—

In order to investigate further the relation of Philippine monkey blood to the known human blood groups, the identity of the monkey agglutinins with that of human group B was tested by means of absorption experiments.

In an experiment given in Table 9 human serum of group A was absorbed by human red cells of group B. Another portion of the same human serum was absorbed by monkey red cells. Thus treated, sera were then tested for agglutination

TABLE 7.—*Showing the results of agglutination tests of monkey red corpuscles by human sera belonging to various groups.*

Human serum No.—	Blood group.	Serum dilution.						
		1/1	1/5	1/10	1/20	1/40	1/80	1/160
7	A	+++	+++	++	±	......	......	......
18	A	—	—	—	—	......	......	......
8	A	+++	......	++	+	—	—	—
9	A	+++	......	+	—	—	—	—
14	A	+++	......	+++	+	—	—	—
15	A	+	......	—	—	—	—	—
9	A	—	......	—	—	—	—	—
3	B	+++	+++	++	±	—	......	......
9	B	+	—	—	—	......	......	......
17	B	—	......	—	—	—	—	......
18	B	+++	......	+	+	—	—	......
19	B	—	......	—	—	—	—	......
18	B	—	......	—	—	—	—	—
22	B	+++	......	—	—	—	—	—
33	B	+++	......	—	—	—	—	—
45	B	+++	......	+	—	—	—	—
1	AB	—	—	—	—	......	......	......
17	AB	—	—	—	—	......	......	......
7	AB	+++	+++	+++	++	—	—	—
2	O	++	++	—	—	......	......	......
13	O	—	—	—	—	......	......	......
8	O	+++	......	++	+	—	—	......
12	O	+++	......	+++	+++	++	++	......
20	O	—	......	—	—	—	—	......
22	O	+	......	—	—	—	—	......
23	O	++	......	+	—	—	—	......
6	O	++	......	—	—	—	—	......
12	O	+++	......	+++	++	++	+	—
21	O	—	......	—	—	—	—	—
5	O	+++	......	++	—	—	—	—
8	O	+++	......	—	—	—	—	—
20	O	+++	......	—	—	—	—	—
26	O	+++	......	+++	+	—	—	—
39	O	+++	......	+++	+++	+	—	—
43	O	+++	......	—	—	—	—	—

with human red cells group B and with monkey red cells. The result was that the human red cells group B absorbed the agglutinins from human serum group A for human corpuscles group B, but not those for monkey corpuscles and vice versa. Further absorption experiments in various combinations performed with monkey serum and red cells, and with human sera and red cells belonging to various groups showed conclusively a distinct specificity of the agglutinins in Philippine monkey serum and of those encountered in human sera (Tables 9, 10, and 11).

TABLE 8.—*Showing the results of agglutination performed with ten samples of monkey red cells and ten samples of human blood sera belonging to various blood groups.*

Human serum.		Monkey red corpuscles.									
No.	Blood group.	Z-1	W-18	L-2	J-15	T-16	Int-2	R-4	f-2	W. R-1	Java-1
3	A	—	—	—	—	—	—	—	—	—	—
5	A	—	+	+	—	—	—	—	—	+++	—
12	A	—	—	—	—	—	—	—	—	—	—
1	B	—	—	—	—	—	—	—	—	+	—
10	B	+	+++	+++	+++	++	+++	+++	+	+++	+
2	O	—	—	—	—	—	—	—	—	—	—
4	O	+	++	+++	+	++	+	+	+	+++	+
7	O	+++	+++	+++	+++	+++	+++	+++	++	+++	+++
8	O	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++
9	O	—	—	—	—	—	—	—	—	—	—

SUMMARY

A series of investigations concerning the relation between human blood groups and the blood of Philippine monkeys showed that the serum of Philippine monkeys contains distinct agglutinins for the human blood group element A. It agglutinates, therefore, red corpuscles of the group A and group AB exclusively. It does not agglutinate human red corpuscles of the other groups. Monkey red cells, on the other hand, are agglutinated by a certain portion of human sera irrespective of the blood group to which they belong. Absorption experiments showed distinct specificity of the anti -A agglutinins in the monkey serum and a distinct specificity of the anti -A agglutinins in human serum. Likewise, the agglutinins contained in some

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TABLE 9.—*Showing the results of agglutination test performed with human serum group A, which has been absorbed by human red cells group B, as compared with human serum of a group absorbed by monkey red cells.*

[Test-tube method.]

HUMAN SERUM GROUP A ABSORBED BY HUMAN RED CELLS GROUP B.

Red cells.	Before absorption.						After absorption.					
	1/10	1/20	1/40	1/80	1/160	1/320	1/10	1/20	1/40	1/80	1/160	1/320
Human group B	+++	+++	+++	++	++	—	—	—	—	—	—	—
Monkey	++	++	++	—	—	—	++	++	+	—	—	—
HUMAN SERUM GROUP A ABSORBED BY MONKEY RED CELLS.												
Human group B	+++	+++	+++	++	++	—	+++	+++	+++	++	++	—
Do	+++	+++	+++	++	+	—	+++	+++	+++	++	+	—
Do	+++	+++	+++	++	+	—	+++	+++	+++	++	++	—
Do	+++	+++	+++	++	+	—	+++	+++	+++	++	+	—
Do	+++	+++	+++	++	+	—	+++	+++	++	++		
Monkey	++	++	++	—	—	—	—	—	—	—	—	—
Do	+++	+++	++	+	—	—	—	—	—	—	—	—
Do	+++	+++	++	++	+	—	—	—	—	—	—	—
Do	+++	+++	++	+	—	—	—	—	—	—	—	—
Do	+++	+++	++	++	+	—	—	—	—	—	—	—

TABLE 10.—*Showing the results of agglutinations performed with human serum group B, which has been absorbed by human red cells group A, as compared with human serum group B absorbed by monkey red cells.*

[Test-tube method.]

HUMAN SERUM GROUP B ABSORBED BY HUMAN RED CELLS GROUP A.

Red cells.	Before absorption.						After absorption.					
	1/10	1/20	1/40	1/80	1/160	1/320	1/10	1/20	1/40	1/80	1/160	1/320
Human group A	+++	+++	+++	++	—		—	—	—	—		
Monkey							+++	++	+	—		

HUMAN SERUM GROUP B ABSORBED BY MONKEY RED CELLS.

Red cells.	Before absorption.						After absorption.					
	1/10	1/20	1/40	1/80	1/160	1/320	1/10	1/20	1/40	1/80	1/160	1/320
Human group A	+++	+++	+++	++	—		+++	+++	+++	+++		
Do	+++	++	+	—	—		+++	+++	++	+		
Do							+++	+++	++	+		
Monkey	++	+	—	—	—		—	—	—	—		
Do	+++	++	+	—	—		—	—	—	—		
Do	+++	++	+	—	—		—	—	—	—		

TABLE 11.—*Showing the results of agglutination test performed with human red cells groups A and B and monkey red cells. Human sera groups A and B and monkey sera absorbed by human red cells groups A and B and by monkey cells were used.*

Red cells used for—		Agglutination test.									
		Before absorption.					After absorption.				
Absorption.	Agglutination.	1/5	1/10	1/20	1/40	1/80	1/5	1/10	1/20	1/40	1/80
Human A	Human A	+++	+++	+++	++	+	—	—	—	—	—
Do	Human B	+++	+++	+++	++	+	+++	+++	+++	++	++
Do	Monkey	+++	+++	+++	++	—	+++	+++	+++	+++	—
Human B	Human A	+++	+++	+++	++	+	+++	+++	+++	+++	—
Do	Human B	+++	+++	+++	++	+	—	—	—	—	—
Do	Monkey	+++	+++	+++	+	—	+++	+++	+++	++	—
Monkey	Human A	+++	+++	+++	++	+	+++	+++	+++	++	+
Do	Human B	+++	+++	+++	++	+	+++	+++	+++	+++	+
Do	Monkey	+++	+++	++	—	—	—	—	—	—	—

TABLE 12.—*Showing the results of agglutination test performed with human red cells groups A and B and monkey red cells. Human serum group O absorbed by human red cells group A and by monkey red cells was used.*

Red cells used for—		Agglutination test.							
		Before absorption.				After absorption.			
Absorption.	Agglutination.	1/10	1/20	1/40	1/80	1/10	1/20	1/40	1/80
Human A	Human A	+++	+++	+++	+++	—	—	—	—
Do	Monkey	+++	+++	+++	+++	++	+++	++	++
Monkey	Human A	+++	+++	++	+	+++	++	++	+
Do	Human B	+++	++	++	++	+++	+++	+++	+++
Do	Monkey	+	—	—	—	—	—	—	—
Do	Human A	+++	++	+	—	+++	++	—	—
Do	Human B	+++	+++	++	+	+	+	—	—
Do	Monkey	++	++	+	—	—	—	—	—
Do	do	++	++	+	—	—	—	—	—

human sera were found to be specific towards monkey red cells and were different from group agglutinins in the human sera.

CONCLUSION

The anti-A agglutinins contained in the serum of Philippine monkeys are different from the anti-A agglutinins contained in human serum type B. However, for the determination of human blood groups, the serum of Philippine monkeys can be used in place of human serum type B.

EXPERIMENTAL INQUIRY INTO THE POSSIBILITY OF TRANSMISSION OF YAWS BY LEECHES

By ISAO MIYAO [1]

Of the Division of Biology and Serum Laboratory
Bureau of Science, Manila

The experimental evidence concerning indirect transmission of yaws has been gathered from the available literature and critically discussed by Yasuyama.[2]

Leeches are mentioned as possible vectors of yaws infection in the literature, on purely speculative grounds, but we failed to find any records of experiments or other convincing evidence to justify such a belief. They are widely distributed throughout tropical marsh lands and freely attack people who in their daily tasks visit these regions. In view of the fact that leeches were found by Boynton [3] to harbor the virus of rinderpest for a long time and that viable plague bacilli were found by Schöbl in the blood ingested by leeches from a plague patient,[4] an inquiry into the possibility of transmission of yaws by leeches appeared to us justified and within the scope of the investigations concerning yaws that have been conducted in our laboratory during the past seven years. Moreover, Robertson in Ceylon [5] demonstrated that leeches may become vectors of *Trypanosoma*-infection, and Sakravoy, Rosenbach, Blumer, and Mitchel [6] noted that malarial parasites remained alive for several days in the blood ingested by leeches from malaria patients.

EXPERIMENTS

Common Philippine leeches secured in a drug store in Manila were used in these experiments. Philippine monkeys inoculated with the Kadangan strain of yaws,[7] which developed typical yaws

[1] Lieutenant Commander Surgeon, Imperial Japanese Navy.
[2] Philip. Journ. Sci. 35 (1928) 333.
[3] Philip. Journ. Sci. § B 8 (1913) 509.
[4] Oral communication.
[5] Quart. Journ. Micr. Sci. No. 213, 54 (1909) 138.
[6] Cited by Bas and Johns, Journ. Exp. Med. 16 (1912) 568.
[7] Philip. Journ. Sci. 35 (1928) 209.

lesions containing treponemas at the moment of the experiment, were employed as donors. The leeches were allowed to ingest the lymph and blood oozing directly from the lesions. After feeding, each individual leech was placed in a separate Petri dish. At definite periods of time, after feeding, the entire blood content of each leech was taken up by an individual sterilized hypodermic syringe, examined microscopically, and inoculated into normal monkeys by intradermal inoculation.

EXPERIMENTAL FINDINGS

The results of the microscopic examination of the content of the leeches after feeding on experimental yaws lesions for treponemas are somewhat irregular. Sixteen trials were made with sixteen leeches, several yaws animals being used as donors of yaws material. Of the sixteen trials, treponemas were not found in five instances. In three instances only one examination was made. In eleven trials treponemas were found in every instance, very often repeatedly.

Since treponemas were found in the leeches after feeding on yaws lesions in a fair percentage of experiments we proceeded to test their viability in the body of the leeches. Six monkeys with experimental yaws lesions containing demonstrable treponemas at the time of the experiment served as donors, and six normal monkeys were inoculated with the content of the leeches fed on yaws lesions. From Table 2 it can be seen that in not a single instance did the inoculation produce a lesion.

DISCUSSION

The search for treponemas in the yaws material after ingestion by leeches, with the help of the dark-field microscope, revealed them in a large percentage of instances when repeated examinations were made. In some trials treponemas were not found when microscopic examinations were made at short intervals after feeding, while they were encountered later when the same material was examined after feeding. This finding may seem to suggest that a certain degree of multiplication takes place in the body of the leech; in other instances, however, reverse findings were made. It merely shows that the treponemas present in the ingested blood were few and unevenly distributed.

Even though present in the body of the leeches the treponemas were not viable as demonstrated by inoculation to normal

TABLE 1.—*Showing the results of microscopic examination of leeches fed upon yaws lesion.*

[+, positive finding; —, negative finding.]

Treponema in the lesion of donor.	Time between feeding and microscopic examination.	Result of darkfield microscopic examination.	*Treponema* in the lesion of donor.	Time between feeding and microscopic examination.	Result of darkfield microscopic examination.	*Treponema* in the lesion of donor.	Time between feeding and microscopic examination.	Result of darkfield microscopic examination.
	Hours.							
+	([a])	—	+	([a])	—	+	24	—
+	0.5	—	+	([a])	—	+	25	—
+	1.25	+	+	1	—	+	11	+
+	25.0	—	+	2	—	+	12	+
+	([a])	—	+	3	+	+	12	+
+	0.5	—	+	23	—	+	13	+
+	2	+	+	23	—	+	23	—
+	([a])	—	+	24	—	+	24	—
+	([a])	—	+	([a])	—	+	12	+
+	0.5	—	+	1.75	—	+	13	+
+	1	—	+	3.5	—	+	23	—
+	1.5	+	+	5	+	+	24	—
+	2	+	+	10	+	+	([a])	+
+	2.5	+	+	12	+	+	13	—
+	3	+	+	23	+	+	14	—
+	23	—	+	24	—	+	([a])	+
+	25	—	+	23	—	+	13	—
+	28	—	+	24	—	+	14	—

[a] Examined immediately.

TABLE 2.—*Showing the results of animal experiments on viability of Treponema pertenue in leeches.*

[+, positive finding; —, negative finding and negative take.]

Treponema in the lesion of donor.	Time between feeding and inoculation to monkeys.	Recipient monkey No.	Result.	
			Microscopic.	Take.
+	Immediately	1–a	—	—
+	Thirty minutes	2–a	—	—
+	One hour	3–a	—	—
+	Two hours	1–b	—	—
+	Three hours	2–b	—	—
+	Immediately	3–b	—	—

highly susceptible animals. Experiments performed in this laboratory by Yasuyama [8] concerning the viability of *Treponema pertenue* and the presence of treponemas in yaws material exposed to unfavorable conditions indicate that a lesion will not

[8] Philip. Journ. Sci. 35 (1928) 333.

necessarily result from inoculation of such material to an experimental animal that shows high susceptibility to yaws when fresh material is inoculated. This observation, previously made, explains the seeming discrepancy between the microscopic findings of treponemas in the leeches as late as twenty-three hours after feeding and inoculations that gave constantly negative results with respect to formation of lesions. The objection that the monkeys, recipients of the yaws material from the leeches, were immune to yaws does not hold, because the same monkeys inoculated subsequently with yaws developed typical yaws.

The results of experiments concerning the viability of *Treponema pertenue* in the body of common leeches in the Philippines show that the possibility of transmission of yaws by these blood-sucking animals is very remote indeed.

ACKNOWLEDGMENT

Thanks are due to Dr. Otto Schöbl, chief, division of biology and serum laboratory, Bureau of Science, Manila, for his suggestions and other courtesies extended in the carrying out of this work.

PERMANGANATE-HIDE-POWDER GRAPH FOR TANNIN ANALYSIS OF WOOD BARKS

RESULTS BY THE MODIFIED HIDE-POWDER METHOD, OBTAINED FROM THE PERMANGANATE DETERMINATION

By Luz Baens and Augustus P. West

Of the Bureau of Science, Manila

ONE PLATE

A number of methods have been suggested for the determination of tannins in woods and barks. In general, the hide-powder method is considered the most accurate. This method is somewhat tedious to carry out and is not favored by some chemists.

Recently we had occasion to determine the tannin content of some Philippine wood barks. We used both the permanganate method and a modification of the official hide-powder method. Our experiments indicated that for certain Philippine wood barks there is a direct relation between the results obtained by these two methods. That is, the results obtained by the permanganate determination may be referred to a graph which gives the corresponding results in terms of the modified hide-powder method. Perhaps this permanganate-hide-powder graph may be of general application for the determination of tannins in wood barks.

EXPERIMENTAL PROCEDURE

In this investigation, the following tropical tree barks were analyzed by both the modified hide-powder and permanganate methods.

1. Bagtikan, *Parashorea malaanonan* (Blco.) Merr.
2. Liusin, *Parinarium corymbosum* (Blm.) Miq.
3. Santol, *Sandoricum koetjape* (Burm. f.) Merr.
4. Bitaog, *Calophyllum inophyllum* Linn.
5. Sakat, *Terminalia nitens* Presl.
6. Kalumpit, *Terminalia edulis* Blco.
7. Talutó, *Pterocymbium tinctorium* (Blco.) Merr.
8. Kariskis, *Albizzia lebbekoides* (DC.) Benth.
9. Kamachile, *Pithecolobium dulce* (Roxb.) Benth.

A description of the trees from which these barks were obtained is given by Schneider.[1] These trees were growing on Mount Makiling near Los Baños in Laguna Province. They were full-grown, mature trees and were selected by Mr. H. M. Curran, of the Bureau of Forestry, who identified the species and shipped the bark samples to our laboratory in Manila.

Samples of these barks were prepared for analysis by first drying them in an oven at 60° C. for about twenty hours. The barks were then filed with a rasp and the filings sieved through a 20-mesh screen. The bark powder which passed through this sieve was used for the analysis.

Moisture determinations were made on all these bark powders, and the results of analysis were calculated on a moisture-free basis.

In preparing our tannin extracts of the wood barks for both the permanganate and hide-powder methods we used the official method employed for making tannin extracts of tea leaves.[2]

In analyzing barks by our modified hide-powder method we followed, in general, the procedures given by the Association of Official Agricultural Chemists[3] for determining the soluble solids and nontannins. We used a quantity of bark estimated by previous experiments to yield approximately 4 grams of tannin per liter of extract. The powdered bark contained in a round-bottomed flask was extracted, with occasional shaking, on a steam bath with 400 cubic centimeters of water for thirty minutes. The mixture was then filtered into a half-liter volumetric flask and the residue washed thoroughly with hot water, the washings draining into the extract contained in the flask below. The filtrate was then cooled to room temperature and diluted to a volume of half a liter giving the standard tannin extract.

To ascertain if the residue contained any more tannin the residue was boiled with water, with occasional shaking, for another half hour and filtered. The filtrate from the residue of each bark analyzed gave negative tests for tannins, showing that all the tanning material was obtained in the first extraction.

[1] Philip. Bur. Forestry Bull. 14 (1916).

[2] Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists (1925) 341.

[3] Op. cit. 73.

The apparatus recommended for the official hide-powder method may give a more complete extraction than the procedure we used. However, with a more complete extraction there is a tendency to remove not only all the tannins but also some of the nontannin material which, for the gravimetric hide-powder method, might tend to interfere with the determination of the true tannin content of the bark.

An aliquot portion of the standard tannin extract prepared according to our procedure was used for the determination of soluble solids according to the official methods except that the extract was maintained at room temperature instead of 20° C. because it is rather inconvenient to maintain that temperature in the Tropics. However, since tropical temperature is usually very uniform throughout the day, any differences in results due to temperature changes would be well within the experimental error.

For the determination of nontannins we again followed, in general, the procedures given by the official methods, except that we kept our prepared chrome-hide powder in a refrigerator to inhibit bacterial growth which tends to decompose hide powder in the Tropics.

In carrying out these procedures we did not correct for moisture retained by the hide powder because experiments in our laboratory showed that the moisture retained by the hide powder was just about equivalent to the moisture in the leather precipitate.

The tannin content of the barks is, of course, the difference between the percentage of soluble solids and nontannins.

In determining tannins in wood barks by the Löwenthal-Procter permanganate method, we followed the official procedure of the Association of Official Agricultural Chemists for determining the tannin content of tea leaves.[4]

The various kinds of tannins are supposed to have different reducing powers. The actual reduction equivalents of most of these tannins have not as yet been worked out accurately. It is rather difficult to prepare the tannins in pure condition since they often occur as mixtures that are not easy to separate.

[4] Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists (1925) 340. Leach, A. E., and A. L. Winton, Food Inspection and Analysis (1920) 383. Procter, H. E., Journ. Soc. Chem. Ind. 3 (1884) 82.

Our results by the permanganate method were expressed in percentage of gallotannic acid. We used the factor 0.0042 gram tannin (gallotannic acid) as equivalent to 1 cubic centimeter of 0.1 normal oxalic acid because that is one reduction equivalent that seems to have been worked out fairly accurately. In case the reduction equivalent of a particular tannin should be worked out and found to be different from that of gallotannic acid and that tannin is known to be present in a certain bark by actual tests, then the results expressed as percentage of gallotannic acid may be converted into the percentage of that particular tannin by multiplying by the proper factor. By expressing the results as gallotannic acid we have a uniform standard of comparison. This would seem to be desirable, especially since little is known of the actual reducing powers of the individual tannins.

The permanganate method for the determination of tannins is very rapid and convenient. This method, however, gives results which are higher than the actual percentage of tannins contained in the wood barks. The reason for this is that not only tannins but other water extractives reduce the permanganate. Most of the water extractives, especially the coloring matter, are carried down with tannin in the gelatin precipitation. The percentage of tannin obtained by the permanganate method is therefore likely to be abnormally high.

Recently we had occasion to analyze some Philippine wood barks for tannins. We used both the permanganate method and our modified hide-powder method. The results are recorded in Table 1.

TABLE 1.—*Tannin analyses of Philippine wood barks by the permanganate and modified hide-powder methods.*

Sample No.	Name of tree bark.	Tannin content.	
		Determined by permanganate method.	Determined by hide-powder method.
		Per cent.	*Per cent.*
1	Bagtikan	5.31	2.64
2	Liusin	10.77	6.82
3	Santol	17.52	11.80
4	Bitaog	26.86	19.12
5	Sakat	36.76	27.38
6	Kalumpit	55.51	42.00

The figures given in Table 1 are the averages of closely agreeing duplicate determinations. As shown by the data the permanganate method gave much higher results than the hide-powder method. The laboratory data for one of these barks (kalumpit) was as follows:

PERMANGANATE METHOD

1 gram of bark gives 100 cc standard tannin extract.

1 gram of bark gives a volume of 250 cc for gelatin precipitation (100 cc tannin extract + 50 cc gelatin salt solution + 100 cc acid sodium chloride solution).

44.9 cc $KMnO_4$ equivalent to 10 cc tannin extract.

18 cc $KMnO_4$ equivalent to 25 cc of filtrate from gelatin precipitate.

$44.9 - 18 = 26.9$.

$26.9 \times 10 = 269$ cc $KMnO_4$ required to oxidize the tannins and other extractives precipitated from 1 gram of bark.

269×0.4209 (oxalic acid factor) $= 113.2$ cc 0.1 *N* oxalic acid.

Gallotanic acid factor used was 0.0042.

$113.2 \times 0.0042 = 0.4755$ gram tannin in 1 gram bark.

$0.4755 \times 100 = 47.55$ grams tannin in 100 grams bark.

100 grams bark contains 14.34 grams moisture.

47.55 grams tannin in 85.66 grams dry bark.

$\frac{47.55}{85.66} \times 100 = 55.51$ per cent tannin in dry bark by permanganate method.

HIDE-POWDER METHOD

1 gram of bark gives 100 cc standard tannin extract.

For soluble solids 100 cc tannin extract gave 0.4270 grams of residue.

For nontannins 100 cc of hide-powder filtrate gave 0.0672 grams of residue.

$0.4270 - 0.0672 = 0.3598$ gram tannin in 1 gram of bark.

$0.3598 \times 100 = 35.98$ grams tannin in 100 grams bark.

100 grams bark contains 14.34 grams moisture.

$\frac{35.98}{85.66} \times 100 = 42$ per cent tannin in dry bark by hide-powder method.

The six samples of wood barks (Table 1) gave aqueous extracts which, though colored, seemed to be unusually free of the kind of coloring matter and other substances which tend to interfere with the hide-powder determination. For this reason these barks were analyzed easily by our modified hide-powder method, and we believe that this method gave the correct tannin content of these barks.

The tannin content of these barks ranged from a low to a high percentage. When these barks were analyzed by the permanganate and modified hide-powder methods and the results plotted in the curve, the resulting graph was found to be almost

a straight line as shown in Plate 1. This would indicate that the reducing power of the tannins in these barks was approximately of the same degree. Extracts from two of these barks of the *Terminalia* species (sakat and kalumpit) gave very positive tests for gallotannins. It would seem that the tannins in the other four barks apparently had about the same reducing power as gallotannic acid.

From a consideration of these facts it would seem that there is a direct relation between the results obtained by the permanganate and modified hide-powder methods when there are no substances present to interfere with the accuracy of the hide-powder method and the tannins present in the barks have the reduction equivalent of gallotannic acid.

If it is true that in the case of gallotannins there is a direct relation between the results obtained by the permanganate and modified hide-powder methods, then to get the correct tannin content of a tree bark it would seem to be only necessary to analyze the bark by the rapid permanganate method and refer the result to our permanganate-hide-powder graph (Plate 1). This gives the corresponding figure representing the tannin content of the bark by the modified hide-powder method for gallotannic acid and other tannins of equal reducing power. For tannins having a different reducing power the percentage of gallotannic acid (obtained from the curve) should be multiplied by the proper reduction equivalent factor if that is known.

In Table 2 are given the results of analyses of three other barks by the permanganate and modified hide-powder methods.

TABLE 2.—*Tannin analyses of Philippine wood barks by the permanganate and modified hide-powder methods.*

Sample No.	Name of tree bark.	Tannin content.		
		Determined by permanganate method.	Determined by hide-powder method.	Hide-powder method corresponding to permanganate results from graph. [a]
		Per cent.	*Per cent.*	*Per cent.*
7	Taluto	15.41	15.41	10.20
8	Kariskis	30.33	23.93	21.90
9	Kamachile	40.31	33.22	30.10

[a] These figures, representing results by the hide-powder method, were obtained from the permanganate determinations by applying the permanganate-hide-powder graph (Plate 1).

With the taluto bark (sample 7, Table 2) both the permanganate and modified hide-powder methods gave the same percentage of tannin. In using the permanganate method, the gelatin precipitate carries down all the coloring matter and possibly other water extractives which, of course, gives a high result.

In using the hide-powder method with this particular wood bark the hide-powder precipitate also appeared to carry down coloring matter and other water extractives, because the filtrate was very much lighter in color than the original extract. Quite likely the hide-powder precipitate carried down the bulk of the coloring matter and water extractives. Naturally, in this case the hide-powder method gives a high result. As a matter of fact, as shown by the data (Table 2), both the permanganate and the hide-powder method gave the same percentage of tannin for this sample of taluto bark. Probably the hide-powder precipitate carried down about the same amount of coloring matter and water extractives as the gelatin precipitate in the permanganate method.

In the case of the kariskis and kamachile barks (samples 8 and 9, Table 2) the hide-powder precipitate carried down a small quantity of coloring matter and water extractives. This made the results for the hide-powder method somewhat high.

From a consideration of our results it would seem that in analyzing barks like our first six samples (Table 1) the hide-powder method gives very accurate results because there are no interfering factors. Where there are interfering factors, as in the case of our barks 7, 8, and 9 (Table 2), the hide-powder method does not give accurate results.

Fortunately, the first six wood barks recorded in Table 1 seemed to serve as ideal samples for the hide-powder method, and we were able to construct a graph showing the direct relation between the results obtained by the hide-powder and permanganate methods. Having once constructed this graph accurately it is not necessary to use the tedious hide-powder method for determining tannins. We have only to employ the rapid permanganate method and refer the results to our graph which gives the corresponding figure representing the accurate tannin content by the modified hide-powder method.

An interesting point in connection with this permanganate-hide-powder graph is that the tannin percentages obtained by it, representing results by the modified hide-powder method,

are always of a minimum value. For instance in the case of the kariskis bark (sample 8, Table 2) the tannin content by the permanganate method gave 30.33 per cent. As indicated by the graph this corresponds to 21.90 per cent tannin by the modified hide-powder method. The actual determination of tannin by the modified hide-powder method gave 23.93 per cent, which is somewhat higher than the result indicated by the graph. In this case the hide-powder method gave a result somewhat abnormally high due to interfering factors. However, by using the rapid permanganate method and referring the result to the permanganate-hide-powder graph the correct tannin content, representing the result by the modified hide-powder method, is obtained.

Similar results were found with the taluto and kamachile barks (Table 2). In each case the hide-powder method gave abnormally high results, but the correct tannin content may be obtained by use of the permanganate method and our permanganate-hide-powder graph.

Obviously there are many advantages in using the rapid permanganate method for determining the tannin content of wood barks. This method is easy to carry out and very rapid. Again the same quantity of sample (5 grams) is used for the analysis of different barks irrespective of the tannin content of these barks.

The hide-powder method, on the other hand, is tedious to carry out and often gives abnormal results due to interfering factors; and this method requires the extract of the sample to contain about 4 grams of tannin per liter. Since the tannin content of wood barks varies greatly it is not easy to estimate in advance the approximate tannin content of a particular bark. Often preliminary analyses are necessary to obtain data for an accurate hide-powder analysis. The standard method of preparing the extract and also the temperature control are other troublesome features of the hide-powder method.

The results of our investigation indicate that the most satisfactory method for determining the tannin content of wood barks is to use the permanganate method and refer the results to our permanganate-hide-powder graph, which gives the corresponding figures representing accurate results for the hide-powder method. By analyzing the tree barks in this manner we can obtain accurate data representing results by the modified hide-powder method even though a particular sample analyzed

may contain disturbing substances which do not permit of an accurate analysis by the hide-powder method.

A few years ago Linde and Teufer [5] made by various methods comparative analyses of three wood barks. Their analyses showed that the hide-powder method gave results somewhat higher than the permanganate method. One of the samples they analyzed was pomegranate bark (*Punica granatum* Linn.). We happened to have in our stock room a sample of pomegranate bark obtained from Parke, Davis & Co. We analyzed this sample by the permanganate and the modified hide-powder method. Our results compared with the data obtained by Linde and Teufer for this bark are given in Table 3. The bark we analyzed contained 6.79 per cent moisture. Our results were calculated on a moisture-free basis.

TABLE 3.—*Tannin analyses of pomegranate bark.*

Method used.	Analysis by—	
	Baens and West.	Linde and Teufer.
	Per cent.	*Per cent.*
Permanganate	23.99	22.35
Modified hide-powder	21.03	
Hide-powder, corresponding to permanganate results from graph	[a] 17.00	
Hide-powder		23.8

[a] This figure, representing the result by the hide-powder method, was obtained from the permanganate determination by applying the permanganate-hide-powder graph.

The tannin content of pomegranate bark may vary somewhat due to environmental factors of growth. However, as shown by the data (Table 3) the permanganate method, as we expected, gave for us a higher result (23.99 per cent) than our modified hide-powder method (21.03 per cent). According to our suggestion for ascertaining the tannin percentage from our permanganate-hide-powder graph this sample we analyzed would contain 17 per cent of tannin calculated as gallotannic acid.

SUMMARY

Nine Philippine wood barks were analyzed for tannins by the potassium permanganate method and the modified-hide powder method. With one exception the permanganate method gave much higher results than the hide-powder method.

[5] Pharm. Zentr. 70 (1929) 21 and 53.

The hide-powder method worked smoothly and easily for six of these barks (Nos. 1 to 6, Table 1) which appeared to contain no particular coloring matter or water extractives that would tend to interfere with this method. For this reason we believe the hide-powder method gave the correct tannin content of these barks, two of which gave very positive tests for gallotannic acid.

When the results by the hide-powder and permanganate methods were plotted for these six barks there was obtained a curve (permanganate-hide-powder graph) which was almost a straight line. This indicates that the tannins in these barks have approximately the same reducing power—about equivalent to that of gallotannic acid. Since the tannin content of these barks ranged from a low to a high percentage it would seem that with these barks there is a direct relation between results obtained by the permanganate and modified hide-powder methods.

Three other wood barks (Nos. 7, 8, and 9, Table 2) gave results by the modified hide-powder method which did not coincide with the permanganate-hide-powder graph. Extracts from these barks seemed to contain substances which interfered with the accuracy of the hide-powder method and gave results which appeared to be too high.

From our experiments it would seem that the hide-powder method is very accurate when the extract contains no interfering substances which give abnormally high results. However, in such cases correct data, representing results by the modified hide-powder method, may be obtained by means of the rapid permanganate method and reference to the permanganate-hide-powder graph, which gives the tannin content of the barks as percentage of gallotannic acid. Should the bark contain a tannin having a different reducing power, then the correct result is obtained by multiplying the percentage of gallotannic acid (obtained from the graph) by the proper reduction equivalent factor (if known) for that particular tannin.

The permanganate method is convenient and easy to carry out but gives results that are too high. We are inclined to think that the data we obtained for the first six barks (Table 1) by the hide-powder method afford a means of standardizing the permanganate method. As a result of our experiments it would seem that, by using the permanganate method and referring to the permanganate-hide-powder graph, the exact tannin content of wood barks by the hide-powder method may be deter-

mined. Perhaps this method may be found to be of general application for all kinds of wood barks.

In this paper we have repeatedly referred to our "modified hide-powder method." As a matter of fact the principal difference between the procedure we used for the hide-powder method and the official procedure is in the manner of extracting the bark. We aim to extract only the tannins and leave as much of the nontannins as possible, because the nontannins may contain substances that interfere with the accuracy of the hide-powder method.

ILLUSTRATION

PLATE 1. Graph showing determination of tannin by the hide-powder method and the potassium permanganate method.

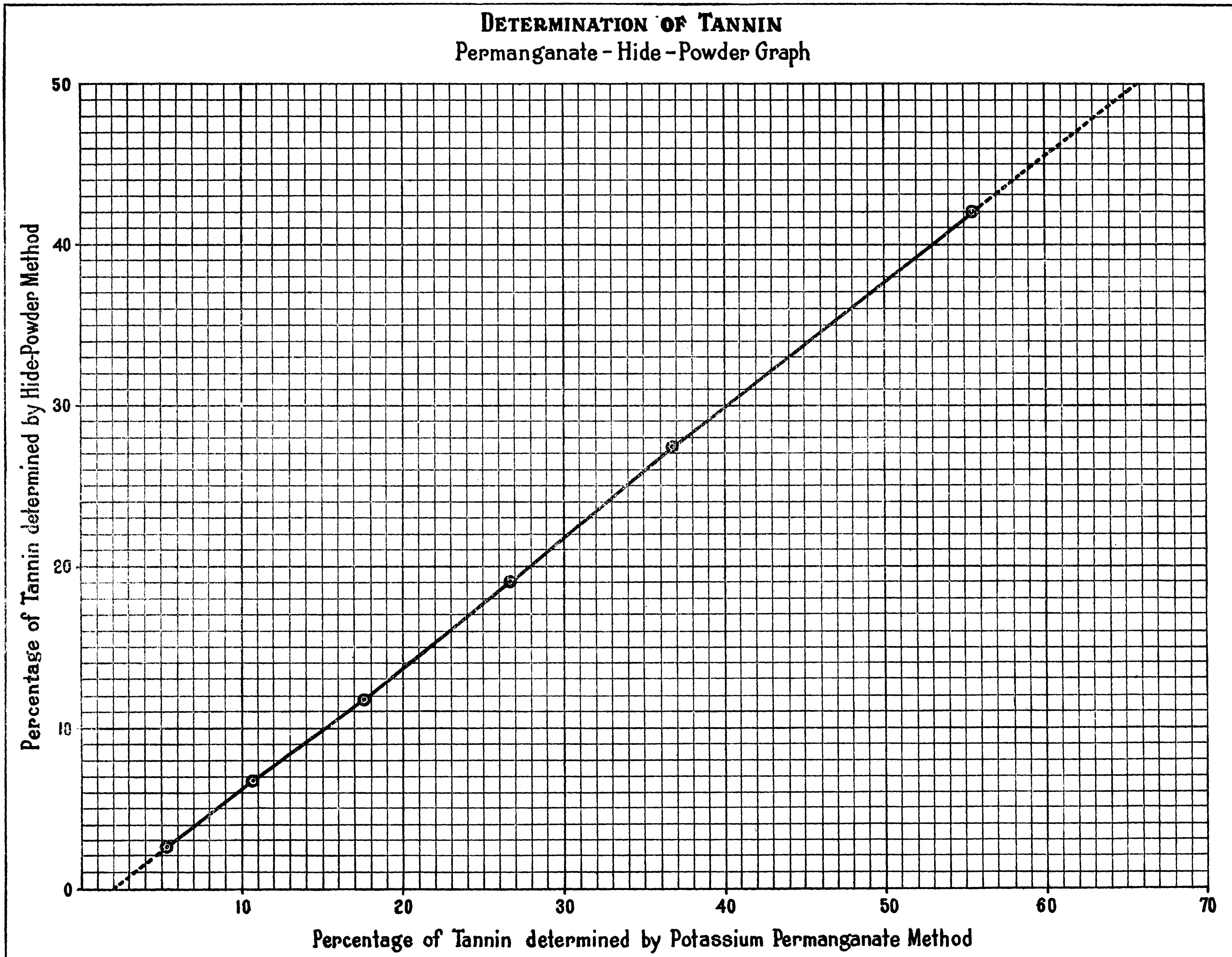

PLATE 1. GRAPH SHOWING THE DETERMINATION OF TANNIN BY THE HIDE-POWDER METHOD AND THE POTASSIUM PERMANGANATE METHOD. THE GRAPH WAS PLOTTED FROM THE DATA GIVEN IN TABLE 1.

CRYSTALLIZED AND DISTILLED ROSIN FROM PHILIPPINE PINE TREES (PINUS INSULARIS ENDLICHER)

By SIMEONA S. TANCHICO and AUGUSTUS P. WEST
Of the Bureau of Science, Manila

and

P. D. ESGUERRA
Of the Bureau of Forestry, Manila

ONE PLATE

The Benguet pine (*Pinus insularis* Endlicher) grows extensively in the mountain regions of northern Luzon. Some months ago the resin content of Benguet pine was investigated[1] and the results showed that it yields a turpentine and rosin of high grade. The rosin is obtained in the usual manner by steam distilling the pine resin; the turpentine passes over into the distillate leaving the crude rosin behind. Our experiments have shown that the crude amorphous rosin may be converted by solvents into a crystallized form. When distilled the amorphous rosin is changed into a transparent glassy variety. Data on these different kinds of rosin from Benguet pine trees have been obtained in this investigation.

EXPERIMENTAL PROCEDURE

The pine resin used in making these different kinds of rosin was collected by Rangers J. Fontanoza and P. D. Esguerra, of the Philippine Bureau of Forestry. Data on the resin from a few individual trees and also on a composite sample from twenty-one trees were obtained. Information concerning these pine trees, method of collecting the resin, and quality of turpentine and rosin obtained have been recorded in previous publications.[2]

Crude rosin.—When the pine tree resin is steam distilled turpentine passes over into the distillate leaving the crude, amor-

[1] Santos, I. de, A. P. West, and J. Fontanoza, Philip. Journ. Sci. **45** (1931) 233; 383.

[2] Santos, I. de, A. P. West, and J. Fontanoza, loc. cit.

phous rosin as a residue in the still. Data on the crude amorphous rosin are given in Table 1.

Crystallized rosin.—The crude amorphous rosin, obtained as a residue in steam distilling the pine resin, contained a small amount of impurities such as chips of bark and twigs.

The crude rosin was dissolved in alcohol (95 per cent) and the solution filtered to remove the chips of bark and twigs. A portion of this alcoholic solution was treated with an equal volume of water and shaken vigorously. The alcoholic solution of the rosin separated in two layers—a supernatant milky solution and a lower oily layer. When set aside for about two hours the lower heavy oil gradually changed to a hard mass. The supernatant milky solution was then decanted into another vessel. The hard mass when dissolved in alcohol and treated with an equal amount of water was again partly converted into the milky solution and a lower oily layer which solidified upon standing. By continuing this process the entire amount of the solid material may be converted gradually into a milky solution. When allowed to stand overnight white rosin crystals gradually precipitated out of the milky solution. The crystals were removed by filtering and dried in a vacuum desiccator. The melting point was 118° C. to 122° C. Data on these rosin crystals are given in Table 1.

Distilled rosin.—The crude amorphous rosin obtained as a residue in distilling the Benguet pine tree resin not only contained impurities, such as chips of bark and twigs, but also a small amount of oily substances which were not removed during the steam distillation. This was indicated by the fact that the rosin was not very hard and brittle and showed a tendency to soften and gradually flow. The crude rosin was dissolved in alcohol (95 per cent) and filtered to eliminate the solid impurities. The alcoholic solution was then distilled on a water bath to remove the alcohol after which the residue was distilled in vacuo, using a Crisco oil bath. During the early stage of the distillation the oily substances passed over into the distillate. The rosin distilled over at a temperature ranging from 244° C. to 250° C. with a pressure of about 2 millimeters. The melted rosin in the distillate was poured into paper moulds and, when allowed to cool, the rosin hardened into a brittle, transparent, amber-colored product. Data on the distilled rosin are given in Table 1.

TABLE 1.—*Analysis of rosin from Benguet pine trees (Pinus insularis Endlicher).*[a]

Constants.	Crude rosin, composite sample.	Crystallized rosin, composite sample.	Distilled rosin.			
			Composite sample.	Tree I–A.	Tree II–A.	Tree III–A.
Melting point °C.:						
Softens	98	113	52	55	50	55
Melts	107	118–122	56	60	55	60
Specific gravity $\frac{30°}{4°}$ C.	1.068	----------	1.147	1.075	1.079	1.079
Acid value:						
Titration with aqueous alkali (A)	165.3	180.4	169.25	161.6	158.45	169.4
Titration with alcoholic alkali (a)	161.2	177.7	167.2	154.5	154.2	162.3
Total saponification value (B):	175.9	181.9	177.4	170.5	164.5	172.7
Ester value (B–A)	10.6	1.5	8.15	8.9	6.05	3.3
Ester value (B–a)	14.7	4.2	10.2	16.0	10.3	10.4
Unsaponifiable matter..per cent	6.68	3.19	7.10	9.57	11.23	9.58
Specific rotation A $\frac{30°}{D}$ C.	—26.95	—48.55	—14.91	— 5.9	— 5.55	— 3.81

[a] Tree I–A had deep-furrowed bark. Tree II–A had slightly furrowed bark. Tree III–A had thin, smooth bark. The composite sample was composed of rosin obtained from the resin of twenty-one Benguet pine trees.

As shown by the data (Table 1) the crystallized rosin gave the highest melting point, acid and saponification values. It also gave the lowest ester value, unsaponifiable matter, and specific rotation.

Data on the various samples of distilled rosin (Table 1) showed that this kind of rosin gave a low melting point and specific rotation but a rather high unsaponifiable matter.

Results obtained in a previous investigation[3] showed that different samples of amorphous Benguet rosin gave a wide range in melting points. As samples of the distilled rosin gave a rather narrow range in melting points it would seem that the distilled rosin is a more uniform product.

Samples of abietic acid were prepared from distilled Benguet rosin by using the complex sodium salt method employed by Kessler, Lowy, and Faragher[4] in making abietic acid. The abietic acid from the distilled rosin gave a melting point of 145° to 148° C. The molecular weight calculated from the neutral-

[3] Santos, I. de, A. P. West, and J. Fontanoza, Philip. Journ. Sci. 45 (1931) 383.

[4] Journ. Am. Chem. Soc. 49 (1927) 2898.

ization value was 301.7. The calculated molecular weight of abietic acid ($C_{20}H_{30}O_2$) is 302.2. The distilled rosin gave an abietic acid which seemed to be more stable than the abietic acid prepared from crude rosin as it did not turn yellow on standing.

SUMMARY

Samples of crude, crystallized, and distilled rosin were prepared from Benguet pine trees and analyzed in this investigation.

The crystallized rosin gave the highest melting point. It also gave the lowest ester value and unsaponifiable matter.

The distilled rosin gave a low melting point and specific rotation but a rather high percentage of unsaponifiable matter.

The distilled rosin would appear to be a more uniform product than the crude rosin as it gave a narrow range in the melting point.

Abietic acid prepared from the distilled rosin seemed to be more stable than when prepared from crude rosin.

ILLUSTRATION

PLATE 1. Distilled rosin from Philippine pine trees (*Pinus insularis* Endlicher); transparency shown by the label photographed through the sample.

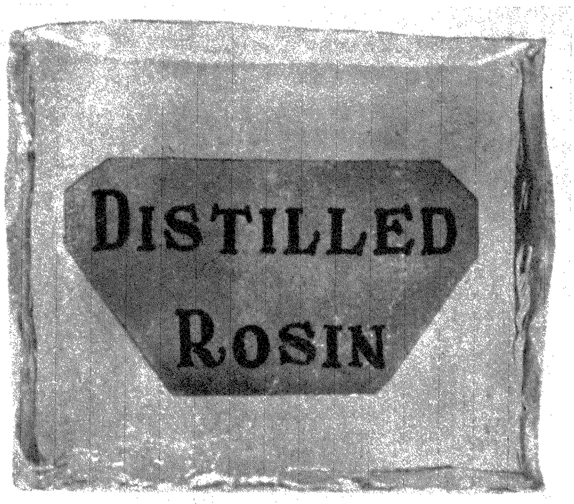

PLATE 1.

COMPOSITION OF PHILIPPINE RICE OIL (HAMBAS VARIETY)

By AURELIO O. CRUZ and AUGUSTUS P. WEST
Of the Bureau of Science, Manila

and

NEMESIO B. MENDIOLA
Of the University of the Philippines

ONE PLATE

As rice is the staple diet of the inhabitants of the Far Eastern countries the rice bran (polishings) naturally accumulates in considerable quantities as a by-product. The bran comprises the seed coat and germ of the rice grain. It is now used for cattle feed and to a slight extent for making tikitiki extract, which is employed in treating the disease known as beriberi.

Rice oil is obtained from the rice bran. Recently we analyzed Philippine rice oil made from bran of the hambas variety of rice. Our results showed that the oil consists principally of glycerides of oleic, linolic, and palmitic acids and is very similar in composition to kapok, cottonseed, and peanut oil. Rice oil has a bland, fatty taste and according to the composition is suitable for various purposes, such as making edible products and soap, for which cottonseed oil may be employed.

Some years ago the attempt was made to produce rice oil commercially, but Lewkowitsch [1] states that the venture was not successful, due, probably, to the low price of oils and fats which prevailed at that time.

When rice bran is stored the oil in the bran hydrolyzes very rapidly with the production of a considerable quantity of free fatty acids. According to Browne [2] this rapid decomposition of the oil is due to a fat-splitting enzyme-lipase. Experiments carried out by Browne indicated that the fat-splitting enzyme contained in the bran could be destroyed by heating the bran

[1] Chemical Technology and Analysis of Oils, Fats, and Waxes 2 (1922) 330.

[2] Journ. Am. Chem. Soc. 25 (1903) 948.

to a temperature of about 90° C. To prevent the formation of free fatty acids in rice bran and the resulting rancidity Browne suggested heating the bran, immediately after milling, to a dry heat sufficient to destroy the enzyme, such as is done in the kiln-drying of certain seeds.

The hambas rice is a Philippine lowland variety, which has been cultivated at the College of Agriculture, University of the Philippines, for some years. The hambas variety is a fast-growing rice but matures rather late, requiring about two hundred days. It yields from about 40 to 80 cavanes per hectare depending upon the growing conditions. The highest yields are obtained by transplanting the rice.

Hambas rice has rather long grains which have an average length of 8.3 millimeters, an average width of 2.7 millimeters, and an average thickness of 1.9 millimeters.

The flavor of cooked hambas rice is considered somewhat better than that of many other varieties of rice.

EXPERIMENTAL PROCEDURE

The hambas rice used in this investigation was milled under the supervision of Dr. Nemesio B. Mendiola, of the College of Agriculture, University of the Philippines. The bran was sieved and that portion which passed through a 40-mesh sieve was used for this investigation.

The sample of rice oil analyzed was obtained from the rice bran by extracting with ether. The ether extract was then filtered and the filtrate distilled to remove the ether. The rice oil was then treated successively (warming, shaking, and filtering) with kieselguhr, suchar, and talcum powder. The brilliantly clear oil thus obtained had a rather dark brown color with a greenish tinge. The yield for this extract was about 18 per cent calculated on a moisture-free basis. The yield varies naturally from about 14 to 21 per cent depending upon the care with which the bran has been milled.

The physical and chemical constants of this sample of hambas rice oil are given in Table 1.

The percentage of saturated acids was corrected for the amount of unsaturated acids which they contain.

The percentage of unsaturated acids was corrected for the amount contained in the saturated acids and also for the unsaponifiable matter which they contain.

TABLE 1.—*Physical and chemical constants of Philippine rice oil (hambas variety).*

Specific gravity at $\frac{30^\circ}{4^\circ}$C	0.9073
Refractive index at 30° C.	1.4667
Iodine number (Hanus)	99.5
Saponification value	188.1
Unsaponifiable matter (per cent)	3.98
Acid value	40.91
Saturated acids, determined (per cent)[a]	20.52
Unsaturated acids plus unsaponifiable matter, determined (per cent)	73.31
Saturated acids, corrected (per cent)	19.72
Unsaturated acids, corrected (per cent)	70.17
Iodine number of unsaturated acids (determined)	124.6

[a] The lead-salt-ether method does not give an accurate separation of saturated and unsaturated acids.

TABLE 2.—*Separation of saturated acids from the unsaturated acids in Philippine rice oil (hambas variety) by the lead-salt-ether method.*

Experiment No.	Oil used.	Unsaturated acids.	Saturated acids.	Unsaturated acids (determined).	Saturated acids (determined).	Unsaturated acids[a] (corrected).	Saturated acids (corrected).
	g.	*g.*	*g.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	10.0606	7.3629	2.0704	73.19	[b] 20.58	70.01	19.80
2	9.6116	7.0567	1.9659	73.42	[c] 20.45	70.33	19.64
Mean				73.31	20.52	70.17	19.72

[a] Unsaturated acids (with unsaponifiable matter removed), iodine number (Hanus), 124.6.

[b] Iodine number (Hanus), 4.7.

[c] Iodine number (Hanus), 4.9.

The saturated and unsaturated acids that occur as glycerides in the hambas variety of Philippine rice oil were separated by the lead-salt-ether method.[3] The results are recorded in Table 2.

The unsaturated acids separated from hambas rice oil by the lead-salt-ether method were treated with bromine and converted into their bromoderivatives.[4] No ether-insoluble hexabromide

[3] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 1 (1921) 556.

Baughman, W. F., and G. S. Jamieson, Cotton Oil Press 6 (1922) 41; Journ. Am. Chem. Soc. 42 (1920) 2398.

[4] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 1 (1921) 585.

was obtained, thus showing the absence of linolenic acid. The composition of the mixed unsaturated acids, which occur as glycerides in hambas rice oil, was calculated from the iodine number of the unsaturated acids. The results are recorded in Table 3. There are also included the calculated percentages of glycerides corresponding to these individual unsaturated acids.

Saturated acids.—The saturated acids were separated from hambas rice oil by the lead-salt-ether method and esterified with methyl alcohol. The mixed acids were dissolved in methyl alcohol and saturated with dry hydrogen chloride gas. The mixture was then heated on a water bath (reflux) for fifteen hours, after which it was treated with water and the ester layer separated. The esters were dissolved in ether and the ethereal solution washed with sodium carbonate solution and afterwards with water. The ethereal solution was then dehydrated with anhydrous sodium sulphate, filtered, and the ether removed by distilling. The impure esters (103.6 grams), which were yellow, were distilled under diminished pressure. A preliminary distillation at about 5 millimeters pressure was made. The esters

TABLE 3.—*Percentage composition of the unsaturated acids of Philippine rice oil (Hambas variety) and the glycerides corresponding to these acids.*

Acid.	Mixture of unsaturated acids.	Original oil.	Glycerides in original oil.
	Per cent.	*Per cent.*	*Per cent.*
Linolic	37.77	26.50	27.69
Oleic	62.23	43.67	45.64
Total	100.00	70.17	73.33

TABLE 4.—*First distillation of the methyl esters of the saturated acids; pressure, 5 millimeters; 103.6044 grams of esters distilled.*

Fraction.	Temperature.	Weight.
	°C.	g.
A	145–175	23.2037
B	175–180	23.2015
C	180–187	25.1687
D	187–190	18.3528
E	190–215	11.0922
Residue	----------	2.40
Total	----------	103.4189

(103.4 grams) were then redistilled at 5 millimeters pressure. Data on the distillation of the esters are given in Tables 4 and 5.

In Table 6, are given the analyses of fractions obtained in the second distillation of methyl esters. From the data (Table 6), there were calculated the amounts of the individual acids corresponding to the methyl esters contained in the various fractions. The results are recorded in Table 7.

In Table 8 is given the composition of the mixed saturated acids and the glycerides in the original sample of hambas rice oil corresponding to these acids.

TABLE 5.—*Second distillation of the methyl esters of the saturated acids; pressure, 5.0 millimeters; 103.4189 grams of esters redistilled.*

Fraction.		Temperature.	Weight.
From first distillation.	Second distillation.		
		°C.	g.
A and B	1	165–171	15.6571
C	2	171–176	29.5003
D	3	176–178	21.1298
E	4	178–180	13.5588
Residue	5	180–183	9.9417
	6	183–210	6.7144
	7	210–225	4.9708
Residue			1.90
Total			103.3729

TABLE 6.—*Analyses of fractions obtained in the second distillation of the mixed methyl esters.*[a]

Fraction.	Iodine number.	Saponification value.	Mean molecular weight of mixed esters.	Composition of mixed esters.		Mean molecular weight of saturated esters.
				Saturated.	Unsaturated.	
				Per cent.	*Per cent.*	
1	1.4	209.0	268.4	98.82	1.18	268.2
2	1.9	206.7	271.4	98.40	1.60	271.0
3	2.8	206.5	271.7	97.64	2.36	271.1
4	5.0	204.8	273.9	95.79	4.21	273.1
5	8.9	202.8	276.6	92.50	7.50	275.3
6	13.8	192.9	290.8	88.37	11.63	290.2
7	9.8	165.1	339.8	91.74	8.26	344.4

[a] Calculated iodine number of unsaturated methyl esters was 118.7. Calculated saponification value of unsaturated methyl esters was 190.0.

TABLE 7.—*Saturated acids corresponding to methyl esters in each fraction.*

Fraction.	Acid.									
	Myristic.		Palmitic.		Stearic.		Arachidic.		Lignoceric.	
	P. cent.	*g.*	*P. cent.*	*g.*	*P. cent.*	*g.*	*P. cent.*	*g.*	*P. cent.*	*g.*
1	6.95	1.09	86.70	13.57						
2			90.97	26.84	2.34	0.69				
3			89.94	19.00	2.66	0.56				
4			81.74	11.08	9.13	1.24				
5			72.06	7.16	15.75	1.57				
6			24.25	1.63	59.85	4.02				
7							59.47	2.96	28.52	1.42
Residue [a]										1.83
Total		1.09		79.28		8.08		2.96		3.25

[a] Residue assumed to be methyl lignocerate.

TABLE 8.—*Saturated acids.*[a]

Acid.	Mixture of saturated acids.			Glycerides in original oil.
	Weight.	Composition.	Proportions in original oil.	
	g.	*Per cent.*	*Per cent.*	*Per cent.*
Myristic	1.09	1.15	0.22	0.23
Palmitic	79.28	83.75	16.51	17.32
Stearic	8.08	8.54	1.68	1.76
Arachidic	2.96	3.13	0.62	0.65
Lignoceric	3.25	3.43	0.68	0.70
Total	94.66	100.00	19.71	20.66

[a] When separated from rice oil the corrected percentage of saturated acids was 19.71.

The composition of hambas rice oil is given in Table 9. There is also included for comparison the composition of a sample of rice oil analyzed by G. S. Jamieson.

In Table 10 is given the composition of Philippine rice oil (hambas) compared to other Philippine and American oils. As shown by the data the rice oil is very similar in composition to kapok, cottonseed, and peanut oils. All of these oils consist principally of glycerides of oleic, linolic, and palmitic acids. They are suitable commercially for the various purposes for which cottonseed oil is employed; that is, the high-grade oils are useful for making edible products, while the lower grades may be employed in soap making.

TABLE 9.—*Composition of rice oil.*

Constituent.	Philippine rice oil (hambas variety).	Rice oil [a] analyzed by G. S. Jamieson.
Glycerides of:		
Unsaturated acids—		
Oleic	45.6	41.0
Linolic	27.7	36.7
Saturated acids—		
Myristic	0.2	0.3
Palmitic	17.3	12.3
Stearic	1.8	1.8
Arachidic	0.7	0.5
Lignoceric	0.7	0.4
Unsaponifiable matter	4.0	4.6
Total	98.0	97.6

[a] This oil was an ether extract of rice bran made by C. E. F. Gersdorff, of the Bureau of Chemistry, Washington.

TABLE 10.—*Comparison of Philippine rice oil (hambas) with other oils.*

Constituent.	Philippine oils.			American oils.	
	Rice oil (hambas).	Kapok-seed oil. [a]	Peanut oil. [b]	Cotton-seed oil. [c]	Peanut oil. [d]
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Glycerides of:					
Unsaturated acids—					
Oleic	45.6	49.8	53.9	35.2	52.9
Linolic	27.7	29.3	27.0	41.7	24.7
Saturated acids—					
Myristic	0.2	0.5		0.3	
Palmitic	17.3	15.9	8.5	20.0	8.2
Stearic	1.8	2.3	3.6	2.0	6.2
Arachidic	0.7	0.8	3.4	0.6	4.0
Lignoceric	0.7		2.4		3.1
Unsaponifiable matter	4.0	0.8	0.3		0.2
Total	98.0	99.4	99.1	99.8	99.3

[a] Philippine kapok-seed oil (*Ceiba pentandra* Gaertner), analyzed by A. O. Cruz and A. P. West, Philip. Journ. Sci. **46** (1931) 131.

[b] Philippine peanut oil (Valencia variety), analyzed by A. O. Cruz and A. P. West, Philip. Journ. Sci. **46** (1931) 199.

[c] American cottonseed oil, analyzed by G. S. Jamieson and W. F. Baughman, Journ. Am. Chem. Soc. **42** (1920) 1197.

[d] American peanut oil (Spanish type), analyzed by G. S. Jamieson, W. F. Baughman, and D. Brauns, Journ. Am. Chem. Soc. **43** (1921) 1372.

The commercial possibilities of rice oil would depend upon the current price and available supply of other oils such as coconut, cottonseed, etc. In case of scarcity of these other oils rice oil may become a commercial product of considerable importance.

A serious drawback to the commercial development of the rice oil industry is that the oil is not easily expressed from the bran. Recently we tried to express the oil from rice bran by using a hydraulic press of the coconut oil mill of the Spencer, Kellogg Company. With a pressure of 4,000 pounds, which is commonly employed for expressing coconut oil, practically no oil was obtained from rice bran. To produce rice oil commercially it would seem that an extraction plant would be necessary.

The authors wish to thank Mr. H. Hellis of the Spencer, Kellogg Company who very kindly permitted us to use a hydraulic press.

SUMMARY

Rice oil is obtained from rice bran which comprises the seed coat and germ of the rice grain.

In this investigation we determined the composition of rice oil obtained from bran of the hambas variety of rice. Our results showed that this kind of rice oil consists principally of glycerides of oleic, linolic, and palmitic acids.

Hambas rice oil is very similar in composition to kapok, cottonseed, and peanut oils. These oils are suitable commercially for the manufacture of edible products and soaps and for other purposes for which cottonseed oil may be employed.

To produce rice oil commercially it would seem that an extraction plant would be necessary.

Rice oil may be an additional source of income for the rice industry.

ILLUSTRATION

PLATE 1. Hambas variety of rice.

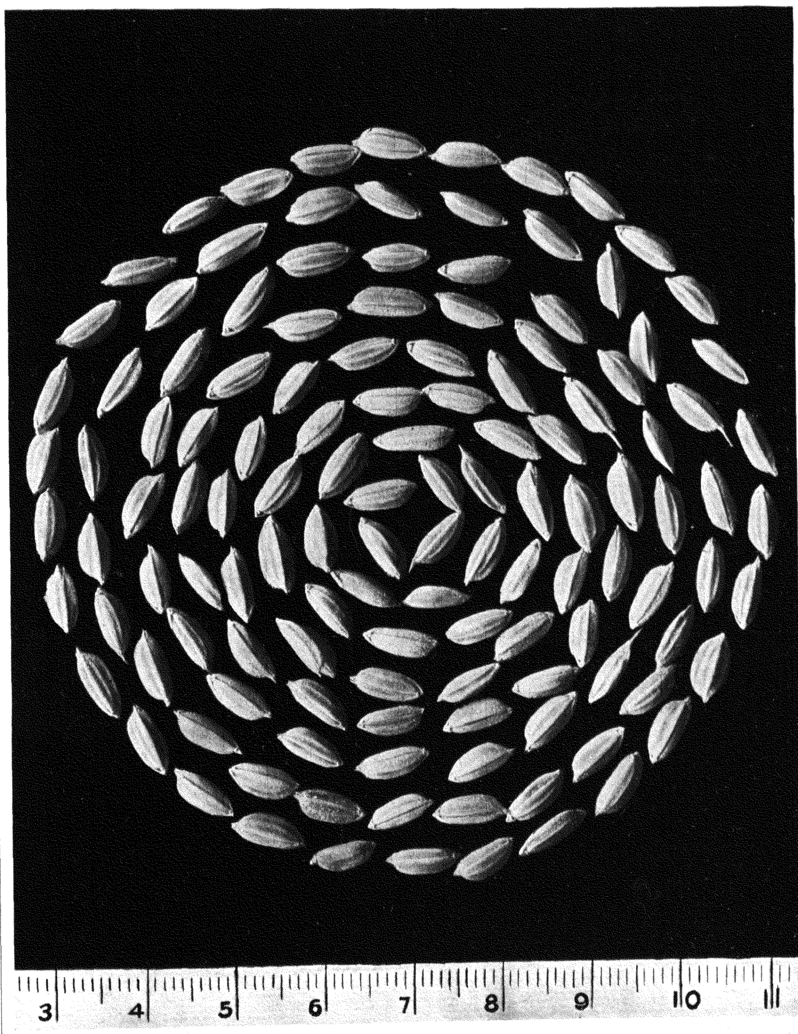

PLATE 1. HAMBAS VARIETY OF RICE.

OBSERVATIONS ON THE LIFE HISTORIES OF EUPARYPHIUM MURINUM TUBANGUI, 1931, AND ECHINOSTOMA REVOLUTUM (FROELICH, 1802), (TREMATODA)

By MARCOS A. TUBANGUI

Of the Division of Biology and Serum Laboratory
Bureau of Science, Manila

THREE PLATES

INTRODUCTION

In February, 1931, samples of a non-operculated, fresh-water snail, *Lymnaea peregra* (Müller),[1] obtained from an irrigation canal that runs through the cultivated fields and pasture grounds of the Trinidad Agricultural School near Baguio, Mountain Province, Luzon, were examined for larval trematodes. About three per cent of the snails were found infested with characteristic echinostome larvæ which, due to their almost uniform behavior and external appearance, were regarded to represent a single species. When, however, the encysted metacercariæ were fed to two white laboratory rats and to a young house pigeon, specimens of two species of adult echinostome flukes armed with thirty-seven and forty-five cephalic spines, respectively, were recovered as a result of the feeding experiment. In view of this, additional lots of the same kind of snail from Trinidad Valley were secured for further studies.[2] Fortunately, what appeared to be the same kinds of trematode larvæ were again encountered, and when the encysted metacercariæ were given to another series of animals (one rat and one young pigeon), identical results were obtained; namely, the recovery from the experimental animals of two species of adult echinos-

[1] This snail (Plate 2, fig. 6) was identified by Dr. H. A. Pilsbry, of the Academy of Natural Sciences, Philadelphia, to whom shells were forwarded through the courtesy of Dr. D. Villadolid, of the College of Agriculture, University of the Philippines.

[2] I wish to express my appreciation to Dr. Cleto Vibar, of the Trinidad Agricultural School, for kindly supplying some of the snails used in these observations.

tomes morphologically similar to those collected in the first experiment.

In order to check up the results, a careful study of the larvæ was made. It was found that the snails in question were infested with two types of echinostome larvæ that resemble each other very closely and can only be differentiated by the number of spines present on their head collars. The cercariæ and metacercariæ of one type of larvæ are armed with thirty-seven cephalic spines, the number and arrangement of which correspond to those of the cephalic spines of one of the two species of adult echinostomes developed experimentally; those of the other type of larvæ are provided with forty-five cephalic spines, also similar in their number and arrangement to the cephalic spines of the other species of adult fluke. After this finding, it was only necessary to plan a final series of controlled feeding experiments in order to obtain incontrovertible evidence concerning the true nature of these larval trematodes. This was done as follows: In previous experiments several infested snails were mixed in one container and the mixture divided among several animals so that it was not known what kind of cysts a particular animal received. In this series each experimental host was fed with only one infected snail which, as far as it was possible to ascertain, harbored only one type of cysts. Satisfactory results were obtained. The metacercariæ armed with thirty-seven cephalic spines developed in the intestines of susceptible animals into adult echinostomes armed with the same number of cephalic spines and those with forty-five spines into adults with a corresponding head armature.

SUMMARY OF FEEDING EXPERIMENTS

The rats employed in the experiments recorded below were fed with a ration consisting of white bread, uncooked camote tubers, and lettuce leaves, and the pigeons with unboiled rice, uncooked mongo beans, and lettuce leaves. None of these different articles of food could have been responsible for any of the positive infestations obtained, as otherwise control and other animals fed on the same rations would have been found similarly infested. It is therefore certain that the resulting infestations were due to the feeding of the animals with snails harboring encysted metacercariæ.

Experiment 1.—February 24, 1931. Bodies of five *Lymnaea* snails harboring encysted metacercariæ cut together into small pieces and fed by means of a medicine dropper to rats 1 and 2, pigeon 1, and one monkey. Fæces of each animal examined every other day for trematode eggs.

March 6. Rats 1 and 2 showed trematode eggs in fæces. Rat 1 killed and from its small intestine three full-grown specimens of a small echinostome (*Euparyphium murinum*) each armed with forty-five cephalic spines were collected. Rat 2 was allowed to live and up to March 25 its fæces were positive for fluke eggs. March 27, or two days later, they were negative, and when the animal was killed no flukes were found in the intestinal tract.

March 8. Pigeon 1 positive. On the morning of March 13 it was found dead inside its cage and on autopsy thirty-three mature specimens of a medium-sized echinostome (*Echinostoma revolutum*), each armed with thirty-seven cephalic spines, were collected from the proximal portion of the large intestine.

March 18. Fæces of monkey negative up to this day.

Experiment 2.—April 14. Three infected snails divided between rat 3 and pigeon 2.

April 27. Rat 3 positive. Killed April 29 and yielded seven adult *Euparyphium*.

April 29. Pigeon 2 positive. Killed and yielded sixteen adult *Echinostoma*.

Experiment 3.—May 17. Rat 4 and 5 and pigeon 3 each fed one snail harboring encysted metacercariæ armed with forty-five cephalic spines; rat 6 and pigeon 4 with cysts armed with thirty-seven cephalic spines. Rat 7 and 8 kept in the same cage as rat 4 and 5 as controls; pigeon 5 in the same cage as pigeon 3 and also used as control.

May 29. Rat 5 positive. Killed and yielded two adult *Euparyphium*.

May 30. Pigeon 4 positive. Killed and yielded seventeen adult *Echinostoma*.

June 1. Rat 4 positive. Killed and yielded five adult *Euparyphium*.

June 9. Rats 6, 7, and 8 and pigeons 3 and 5 negative up to this day. Killed and found free of flukes.

MORPHOLOGY OF EUPARYPHIUM MURINUM DURING DIFFERENT STAGES OF ITS DEVELOPMENT

Larval stages found in snails.—The cercaria of *Euparyphium murinum* (Plate 2, fig. 4) possesses the characteristic echinostome appearance and behaviour. In the fully developed state it is very active and is a good swimmer. During swimming the body is curled ventrally and is propelled by the vigorous lashing of the tail. If prevented from swimming, as when it is compressed under a cover glass or when the tail becomes detached from the body, movement is accomplished by the alternate attachment of the two suckers to the substratum.

The cercaria is capable of extreme contraction and extension, hence it is difficult to measure accurately in the living state. The measurements given below are based on stained, moderately extended specimens mounted in balsam. Body elongate, its lateral margins nearly parallel, broadly attenuated anteriorly, with a slight median depression at its posterior end where the tail is attached; it measures 0.32 to 0.40 by 0.08 to 0.10 millimeter. Tail measures 0.38 to 0.40 millimeter in length by 0.035 to 0.040 millimeter in maximum width near its base; it gradually narrows to a point towards its posterior end. Cuticle of body thickly covered with very minute spines. Beneath cuticle are numerous, roundish to pyriform cystogenous cells, 8 to 16 microns in diameter, filled with opaque granular material, due to which several important internal structures, especially the small excretory vessels, are obscured from view. Head collar prominent, reniform, 0.075 to 0.083 millimeter across. It bears forty-five spines, the arrangement of which is quite identical with the arrangement of the cephalic spines of the adult stage of the worm; the spines measure 13.3 to 22.0 by 3.3 to 4.5 microns, the size depending upon the age of the cercariæ, the young forms possessing smaller needle-shaped spines. Oral sucker subterminal to terminal, 0.033 to 0.041 millimeter in transverse diameter; acetabulum behind middle of body length, slightly larger than oral sucker, 0.045 to 0.058 millimeter across. Mouth ventroterminal, on the dorsal lip of which are found the terminals of four pairs of ducts, leading probably from salivary glands, the position of which was not ascertained; pharynx 0.016 to 0.020 by 0.014 to 0.016 millimeter in size, separated from oral sucker by prepharynx 0.012 to 0.016 millimeter long; œsophagus 0.104 to 0.154 millimeter long, made up of a column of finely granular cells and bifurcates immediately in front of acetabulum; intestinal cæca simple, also composed of columns of cells, pass on each side of acetabulum and reach to near posterior end of body.

Reproductive system represented by two pyriform masses of cells, one slightly anterior and the other posterior to acetabulum, connected by a longitudinal strand of cells.

Excretory system typically echinostome in arrangement. Excretory bladder small, oval, median, at posterior end of body; it is sometimes divided into two portions by a transverse constriction and opens to exterior through a small median pore on dorsal surface of body at point of attachment of tail. A longi-

tudinal caudal collecting tube arises from posterior end of bladder and extends to near tip of tail, where it apparently ends blindly; near its proximal end this tube gives off a pair of lateral branches that open outside through lateral openings. Two main collecting tubes that are conspicuous due to their size and to the large fatlike globules which they inclose arise from anterolateral regions of bladder; these follow a slightly wavy course lateral to intestinal cæca and œsophagus and on reaching the level of pharynx each tube bends towards median line, forms a loop and is continued posteriorly as a small collecting tubule. The latter on reaching the level of excretory bladder forms another loop and apparently takes an anterior course. Due to the presence of the opaque cystogenous cells already referred to, it was not possible to trace the minute excretory vessels or capillaries. It is believed, however, that the flame cells found, of which there are twenty-two on each side of the body, or a total of forty-four, and which are distributed as shown in Plate 2, fig. 4, represent the total number possessed by this cercaria.

This cercaria like other echinostome cercariæ develops in rediæ, of which two kinds were encountered in the digestive and rarely in the reproductive glands of infested snails; namely, young immature forms with only germ cells and mature forms inclosing germ balls, cercariæ, and sometimes encysted metacercariæ. The young rediæ (Plate 2, fig. 2) differ from the mature rediæ by their small size and active movements. They are bluntly rounded anteriorly, somewhat attenuated posteriorly, and measure 0.34 to 0.42 by 0.07 to 0.08 millimeter. They possess near the anterior end a conspicuous collar and near the posterior end a pair of blunt locomotor appendages. To one side of the body behind the collar is found a birth pore. The mouth is anteroterminal and is followed first by a prominent pharynx 0.037 to 0.050 by 0.040 to 0.045 millimeter in size and then by a rhabdocœle gut that may extend posteriorly up to the level of the locomotor appendages. The excretory system appears to consist of two clusters of flame cells with their ducts, the course of which was difficult to determine. There were seen a group of five flame cells near the level of the locomotor appendages and another group of the same number of cells in the middle of the body length.

The mature rediæ (Plate 2, fig. 3) are essentially similar in structure to the young ones. They are less active and often

they do not exhibit any movement at all. They are usually colored with a brownish tinge. Their usual appearance is, as aptly described by Lebour (1908) and by Johnson (1920) for the rediæ of related cercariæ, that of a stocking viewed from the side, the locomotor appendages being at the angle of the stocking. They are filled with five to eighteen cercariæ in different stages of development, besides an equally variable number of germ balls and sometimes encysted metacercariæ. They measure 1.30 to 1.80 by 0.20 to 0.24 millimeters. The pharynx is 0.062 to 0.087 by 0.030 to 0.040 millimeter in size. The rhabdocœle gut is relatively very short and is often pushed to one side by the inclosed cercariæ.

The cercariæ of the majority of digenetic trematodes in the fully developed state leave their molluscan intermediate hosts in order to swim freely in the water and seek opportunities that will enable them to enter into their final hosts. The cercaria of *Euparyphium murinum*, however, like that of *Echinostoma revolutum* and related echinostomes, seems to lead, if at all, only a very brief free-living existence; for it is capable of encysting within its redia or in the tissues of its snail host immediately after issuing from its redia. The process of encystment is accomplished by the liberation of the contents of the cystogenous cells. The secretion collects around the body surface and on hardening forms an efficient protective envelope for the inclosed larva which has cast off its tail preparatory to encystment. It is now known as a metacercaria or adolescaria and represents the infective stage of the life cycle. It does not differ essentially in structure from the cercaria. The cysts (Plate 2, fig. 5) are spherical and are 145.6 to 185.0 microns in diameter. The cyst wall is 6 to 12 microns in thickness and consists of two layers—a thick, external, gelatinous layer and a thin, membranous, internal layer.

Adult stage.—The adult stage (Plate 1, fig. 1) possesses the characters assigned to the genus *Euparyphium* Dietz, 1909, and is probably identical with *Euparyphium murinum* Tubangui, 1931, described from wild rats. A comparison of the two sets of specimens has revealed no significant difference, except in the position of the cirrus sac. In the type specimens from a wild rat the cirrus pouch often extends posteriorly much beyond the equator of the acetabulum. In those from the experimental white rats it rarely reaches the equator of the acetabulum; in

the majority of cases the bulk of the organ is found anterior to the ventral sucker. In view of the taxonomic significance attached to the location of this structure, especially in the family of trematodes to which this parasite belongs, the difference may be considered of sufficient importance to place the experimental flukes in a separate species. It is now recalled, however, that the type specimens of *Euparyphium murinum* were collected from a rat that had been dead for at least twenty-four hours and were in a semidecomposed state when preserved. It is possible, therefore, that the loss of muscle tonus and other factors accompanying the process of decomposition might have had something to do with the seemingly abnormal position of the cirrus pouch. The brief description following is based on specimens from experimental rats:

Body small, elongate, 3.65 to 5.00 by 0.50 to 0.60 millimeters in size; lateral margins from behind cephalic collar to acetabulum slightly inrolled ventrally. Cuticle armed with prominent spines, ventrally from anterior end to level of second testis and dorsally from anterior end to acetabulum. Head collar reniform, 0.20 to 0.28 millimeter across, armed with forty-five spines arranged as follows: Five corner ventral spines on each side, more or less bunched together and measuring 35.3 to 41.6 by 7.9 to 8.3 microns; thirty-five marginal spines arranged in two alternating rows and measuring 35.3 to 45.7 by 8.3 to 9.1 microns. Oral sucker 0.08 to 0.12 by 0.09 to 0.12 millimeter in size; pharynx 0.09 to 0.12 by 0.08 to 0.09 millimeter, separated from oral sucker by very short prepharynx; œsophagus 0.10 to 0.14 millimeter long, bifurcates about midway between pharynx and acetabulum; intestinal cæca simple, reach to near posterior end of body. Acetabulum 0.28 to 0.36 millimeter in diameter, usually at middle of anterior fourth of body length.

Testes tandem, postovarial, at third fourth of body length, with smooth borders or constricted at middle into anterior and posterior lobes; first testis usually smaller, measuring 0.42 to 0.48 by 0.17 to 0.24 millimeter; posterior testis 0.50 to 0.64 by 0.18 to 0.26 millimeter. Cirrus sac oval, 0.20 to 0.40 by 0.12 to 0.16 millimeter in size, rarely reaching posteriorly to equator of acetabulum, its greater bulk in the majority of cases being found in front of the ventral sucker; incloses prominent seminal vesicle, pars prostatica, and protrusible cirrus. Common genital opening near median line, immediately behind œsophageal bifurcation.

Ovary slightly oval, preëquatorial, 0.18 to 0.25 by 0.16 to 0.20 millimeter in size. Shell gland larger than ovary, between latter and anterior testis; receptaculum seminis absent, Laurer's canal present. Uterus short, between intestinal cæca, ovary, and acetabulum, filled with few eggs. Vitellaria in large distinct follicles, extending from about midway between acetabulum and ovary to posterior end of body; they are extracæcal anteriorly but behind second testis follicles of two sides unite in median line and occupy most of the space in this region of the body.

Main portion of excretory system typically echinostome in arrangement. Excretory bladder moderately long, with five pairs of lateral branches that ultimately break up into capillaries; it opens outside through a median, posteroterminal, excretory pore. Behind the second testis the bladder divides into two principal branches, the main collecting tubes, which follow a more or less straight course towards the anterior end; on reaching the level of the pharynx each tube makes a loop and turns posteriad. It was not possible to trace the smaller excretory vessels, but there were counted sixty-six flame cells on each side of the body, the distribution of which is shown in Plate 1, fig. 2.

The eggs are oval, yellowish, operculated at one pole; egg shell thin throughout except at nonoperculated pole where there is a slight thickening; they measure in the fresh state 79.0 to 95.6 by 54.0 to 66.5 microns and are in the one-cell stage when evacuated with the fæces of the host. The progress of their development was not watched day by day but it was determined, if left in a suitable container with a small amount of tap water at room temperature (25° to 31° C.), that they attain the miracidial stage after seven to ten days.

The mature miracidium (Plate 2, fig. 1) almost completely fills the entire space within the eggshell except what is occupied by two or three large fatlike globules that probably represent the remnant of the yolk material originally found surrounding the embryo. It has a characteristic appearance, its anterior end being produced into a small retractile process devoid of cilia. The rest of the body surface is covered with longitudinal rows of long cilia, with which the organism is enabled to swim in the water when it escapes from its shell. A conspicuous eyespot is present in the median line near the anterior end. Like other miracidia, it possesses a primitive sacculate gut, a pair of secretory glands and a number of germinal cells. The excretory system is represented by two flame cells, one on

each side of the median line near the equator of the body. Each cell is provided with a duct that leads to the exterior through a marginal opening. No attempt was made to observe the early behavior of the miracidium in the body of its molluscan host.

MORPHOLOGY OF ECHINOSTOMA REVOLUTUM DURING DIFFERENT STAGES OF ITS DEVELOPMENT

The adult stage of this parasite has been described from wild and domestic ducks, as well as from the goose, fowl, pigeon, and various wild aquatic birds, by many authors, notably by Looss (1899) in Egypt, Dietz (1910) in Europe, Johnson (1920) in North America, and Lutz (1924) in South America. It was recently reported by Tubangui (1931) from a Philippine domestic duck. Its experimental development in pigeons is of interest in connection with the question raised by Krause (1925*b*) on the identity of a fluke, *Echinostoma columbae*, described by Zunker (1925) from a house pigeon in Germany. Krause (1925*a*) had previously reported an echinostome which was the cause of an epizoötic among domestic pigeons in Germany and which he believed to be identical with *Echinostoma revolutum*. According to him, his specimens are similar to those described by Zunker; hence, he would consider *Echinostoma columbae* as a synonym of *Echinostoma revolutum*.

The life history of or, at least, the mode of infestation with this trematode has recently been studied by Johnson (1920) and by Lutz (1924). The snails that have been determined to play the rôle of intermediate hosts and to which should now be added *Lymnaea peregra* are *L. stagnalis*, *Physa occidentalis*, and *P. rivalis*. The following account of the different stages of the life cycle of the parasite is, therefore, necessarily brief and is intended mainly for comparison with that of *Euparyphium murinum* and with Johnson's observations.

Larval stages found in snails.—The cercaria of *Echinostoma revolutum* is very similar to that of *Euparyphium murinum* and, as already stated, can only be distinguished from it with certainty by the number of its collar spines. In moderately extended, stained specimens mounted in balsam the body measures 0.33 to 0.52 by 0.15 to 0.25 millimeter; tail 0.40 to 0.48 by 0.037 to 0.050 millimeter. Entire body surface thickly covered with very minute spines. Cephalic collar 0.090 to 0.125 millimeter across, bears thirty-seven spines arranged in two

alternating rows and measuring 10.4 to 12.5 by 2.0 to 3.0 microns. Oral sucker 0.054 to 0.062 by 0.050 to 0.062 millimeter in size; pharynx 0.025 to 0.030 by 0.020 to 0.027 millimeter, separated from oral sucker by very short prepharynx; œsophagus 0.095 to 0.145 millimeter long, bifurcates in front of acetabulum into two intestinal cæca that extend to near posterior end of body. Acetabulum behind middle of body length, 0.058 to 0.075 by 0.062 to 0.083 millimeter in size.

Genital anlage very similar in appearance and location to that of *Euparyphium murinum.* Main portion of excretory system also similar to that of latter in arrangement. Due to scarcity of material and to the presence of numerous cystogenous cells in the body, I was unable to trace the smaller excretory vessels and the distribution of the flame cells.

Development also takes place in rediæ that are difficult to distinguish from the corresponding stages of *Euparyphium murinum.* The active, young rediæ measure 0.32 to 0.46 by 0.08 to 0.10 millimeter, the mature ones 0.72 to 1.90 by 0.16 to 0.25 millimeters. The pharynx in both forms is globular and of about the same size, measuring 0.033 to 0.041 millimeter in diameter.

The encysted metacercariæ are spherical, 150 to 160 microns in diameter; the cyst wall is 5 to 9 microns in thickness. They were found most abundantly in the connective tissues of the liver and reproductive organs of infected snails; occasionally they occur in small numbers inside the mature rediæ. They can only be distinguished from the metacercariæ of *Euparyphium murinum* by counting the number of the collar spines.

Adult stage.—Total length of mature worms (Plate 3, fig. 1) from experimental pigeons 4.50 to 9.30 millimeters; maximum breadth 1.05 to 1.65 millimeters, behind acetabulum; lateral margins of body from behind collar to acetabulum inrolled ventrally. Cuticle armed with prominent spines, dorsally from anterior end to acetabulum and ventrally from anterior end to level behind second testis. Head collar 0.50 to 0.70 millimeter across, armed with thirty-seven principal spines and, in some cases, a variable number (1 to 3) of accessory spines. Principal collar spines arranged as follows: Five corner ventral spines on each side more or less bunched together, measuring 66.5 to 91.5 by 14.5 to 17.8 microns, the first two inner spines on both sides being usually smaller; twenty-seven marginal spines arranged in two alternating rows, uninterrupted dor-

sally, more or less uniform in size, measuring 79.0 to 99.8 by 16.5 to 20.8 microns. Accessory spines 30.0 to 41.6 by 8.0 to 12.0 microns in size, usually among principal corner spines. Oral sucker 0.22 to 0.30 by 0.22 to 0.28 millimeter in size; pharynx 0.20 to 0.24 by 0.16 to 0.20 millimeter; prepharynx very short; œsophagus 0.32 to 0.40 millimeter long, bifurcates in front of acetabulum; intestinal cæca simple, reach to near posterior end of body. Acetabulum measures 0.74 to 0.80 by 0.70 to 0.80 millimeter; in large extended specimens it is located behind middle of anterior fourth of body length, while in small contracted specimens at junction of first and second fourth of body length.

Testes tandem, postovarial in third fourth of body length; shape variable—elongate and with smooth borders or with transverse constriction at middle; or shorter and with transverse constriction or divided into three to five lobes each; anterior testis usually smaller, measuring 0.28 to 0.70 by 0.26 to 0.54 millimeter, posterior testis 0.34 to 0.84 by 0.28 to 0.46 millimeter. Cirrus sac 0.36 to 0.44 by 0.20 to 0.36 millimeter in size, in front of equator of acetabulum, its greater bulk between this organ and œsophageal bifurcation; incloses seminal vesicle, pars prostatica, and protrusible cirrus. Common genital opening median or slightly to one side of median line, preacetabular, almost directly ventral to œsophageal bifurcation.

Ovary slightly compressed, median, almost equatorial, measuring 0.18 to 0.32 by 0.20 to 0.40 millimeter. Shell gland as big as or even larger than ovary, usually median and between ovary and first testis, but sometimes displaced slightly anteriorly and to one side of median line; receptaculum seminis absent, Laurer's canal present. Uterus moderately developed, containing many eggs. Vitellaria in moderately large follicles, from posterior level of acetabulum to near posterior end of body; the follicles of the two sides are usually separate throughout, but in rare cases they become confluent behind second testis.

Main portion of excretory system similar in arrangement to that of *Euparyphium murinum*. The excretory bladder, however, is much longer and is often slightly coiled at its posterior portion. I was unable to trace the smaller excretory vessels, but there were counted sixty-three pairs of flame cells, the distribution of which is shown in Plate 3, fig. 2.

The eggs have the same shape and color as those of *Euparyphium murinum;* they measure in the fresh state 89.5 to 108.0

by 58.2 to 70.5 microns. Kept in water at room temperature (25° to 31° C.), they attained the miracidial stage after seven to nine days.

DISCUSSION

It is evident from the descriptions that there are no fundamental differences in the life histories of the two echinostomes studied. In conformity with the known sequence of development of digenetic trematodes in general, the various stages of their life cycles may be rearranged as follows: Egg, miracidium, redia, cercaria, encysted metacercaria, and adult. They both agree, therefore, with other echinostomes in the absence of sporocyst stages, their miracidia after gaining entrance into the body of their molluscan intermediate hosts apparently developing directly into rediæ. Other trematodes, such as the blood flukes, lack the redial stage instead and, according to Sewell (1922), the omission is made good by the production of secondary sporocysts from the primary sporocysts. In the case of echinostomes and other flukes that do not pass through a sporocyst cycle, the omission may also be compensated by the production of a succession of redial stages. In the present observations no evidence of this mode of substitution was seen, but Johnson (1920) in his studies on the life history of *Echinostoma revolutum* described what he termed "mother- and daughter-rediæ," the latter developing from the former.

According to Faust (1929), Johnson (1920), Lebour (1908), and Lutz (1924), the cercariæ of some echinostomes encyst within their rediæ or in the tissues of their intermediate hosts after the escape of the cercariæ from the rediæ; others leave their molluscan hosts and encyst in water, on plants, in planarians, in other mollusks, or in the bodies of lower vertebrates, such as, fishes and tadpoles. The occurrence of the encysted metacercariæ of *Echinostoma revolutum* and *Euparyphium murinum* within their rediæ and in the tissues of their molluscan hosts has been mentioned. In addition, observations were made in order to determine if the cercariæ of the two parasites are also capable of encysting in water, but only negative results were obtained. In every instance there was observed under the microscope a liberation of the secretion of the cystogenous glands around the body surface of a cercaria, but the resulting cyst wall appeared weak and soft and the inclosed larva looked degenerate and ready to disintegrate. It is possible that the

cercariæ on which the observations were made were not fully mature and, therefore, were not yet ready to encyst. To check this, samples of water containing snails that later were found infested were examined repeatedly after being centrifuged, but at no time were cysts encountered.

From the standpoint of infection, only the encysted metacercariæ of these two parasites are capable of developing into adult worms if fed to suitable vertebrate hosts. This is true of the large majority of digenetic trematodes. In the case of the metacercaria of *Echinostoma revolutum,* judging from the results of the feeding experiments, development to adulthood was observed to take place only in pigeons. It was unable to infect rats and a monkey, so that it would seem that it is strictly a bird parasite. In fact, as already mentioned, it has been reported from various kinds of birds but never yet from a mammal. On the other hand, the metacercaria of *Euparyphium murinum* developed in rats but not in the other experimental animals. Whether or not, however, it is capable of infesting other hosts, can only be decided by more feeding tests.

It is generally believed that there exists a specific resemblance between echinostome cercariæ and their adults with regard to the number of spines on their head collars. The results of the present study sustain this view, for it was shown that both the cercaria and the adult form of *Echinostoma revolutum* possess thirty-seven cephalic spines and the corresponding stages of *Euparyphium murinum* forty-five spines. Johnson (1920), on the other hand, counted forty-three spines on the collar of the cercaria of *Echinostoma revolutum* and only thirty-six to thirty-seven on that of the adult. He explained the reduction in the number of spines from cercaria to adult as due to "the ease with which any of the spines can be lost unless the worms are handled very carefully, and the fact that there is not enough room on the collar for more spines." On the basis of the present observations and of what is generally believed, it is perhaps more probable that he described the cercaria of a different species of echinostome.

Due to the difficulties involved, it was not possible to trace the fine excretory tubules that connect the flame cells with the principal excretory vessels for either *Echinostoma revolutum* or *Euparyphium murinum.* It is believed that the total numbers and distribution of the flame cells have been determined in the adult of *Echinostoma revolutum* and in the cercaria and adult

of *Euparyphium murinum.* In the case of the latter parasite, the cercaria possesses twenty-two pairs of flame cells and the adult sixty-six pairs. The increase in the number of the cells in the adult is no doubt due to the multiplication of the excretory cells of the cercaria during its growth into adulthood. Such a process of multiplication in a manner that the total number of flame cells in the adult is an exact multiple of those originally present in the cercaria is supposed to take place in all digenetic flukes (Faust). In this case the multiple is "3." In *Echinostoma revolutum,* the adult of which possesses sixty-three pairs of flame cells, assuming that this number is the result of a similar multiplication process, the flame cells of the cercaria may be calculated as being twenty-one pairs. Johnson described the cercaria of this parasite as possessing twenty-four pairs of flame cells, but, as already stated, he probably dealt with a different form of larva.

GENERAL SUMMARY

Snails (*Lymnaea peregra* Müller) obtained from an irrigation canal in Trinidad Valley, near Baguio, Mountain Province, Luzon, were found infested with two kinds of echinostome larvæ (trematodes) distinguishable from each other only by the number of spines on the head collars of the cercariæ and metacercariæ.

Encysted metacercariæ possessing thirty-seven cephalic spines, when fed to experimental animals, developed into adult worms in young house pigeons after twelve to fifteen days; they failed to infect rats and a monkey. The adult parasites have been identified as *Echinostoma revolutum* (Froelich, 1802).

Encysted metacercariæ with forty-five cephalic spines, when fed to experimental animals, developed into full-grown adults in white laboratory rats after ten to fifteen days; they failed to develop in young pigeons and in a monkey. The adult worms have been identified as *Euparyphium murinum* Tubangui, 1931.

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ILLUSTRATIONS

ABBREVIATIONS

ac, acetabulum.
bp, birth pore.
c, collar.
cc, cephalic collar.
ccr, cercaria.
cp, cirrus pouch.
ct, caudal collecting tube.
eb, excretory bladder.
ep, excretory pore.
fc, flame cell.
ga, genital anlage.
gb, germ ball.
gp, genital pore.
int, intestinal cæcum.
la, locomotor appendage.
mt, main collecting tube.
œ, œsophagus.
ov, ovary.
ph, pharynx.
rg, rhabdocœle gut.
sg, shell gland.
t, testis.
ut, uterus.
vg, vitelline gland.

PLATE 1. EUPARYPHIUM MURINUM TUBANGUI, 1931

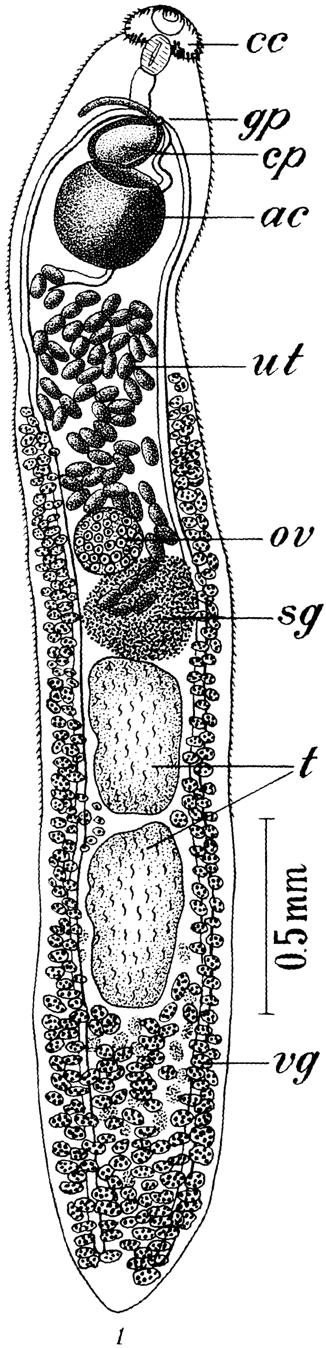
FIG. 1. Entire worm, ventral view, showing reproductive and digestive systems.
2. Outline of main excretory vessels and flame cells.

PLATE 2. STAGES OF EUPARYPHIUM MURINUM, EXCEPT FIG. 6

FIG. 1. Egg inclosing fully developed miracidium.
2. Young redia.
3. Mature redia inclosing cercariæ and germ balls.
4. Cercaria.
5. Encysted metacercaria.
6. Shells of *Lymnaea peregra* (Müller), ventral, lateral, and dorsal views.

PLATE 3. ECHINOSTOMA REVOLUTUM (FROELICH, 1802)

FIG. 1. Entire worm, ventral view, showing reproductive and digestive systems.
2. Outline of main excretory vessels and flame cells.



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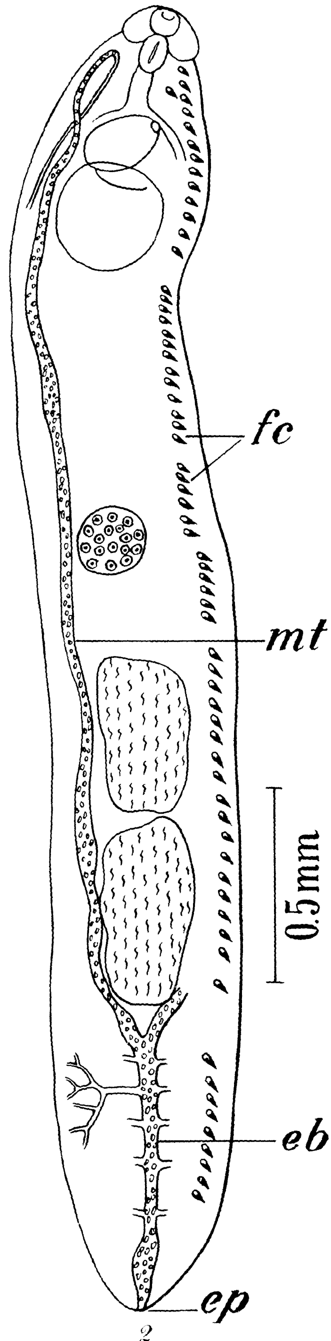

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PLATE 1.

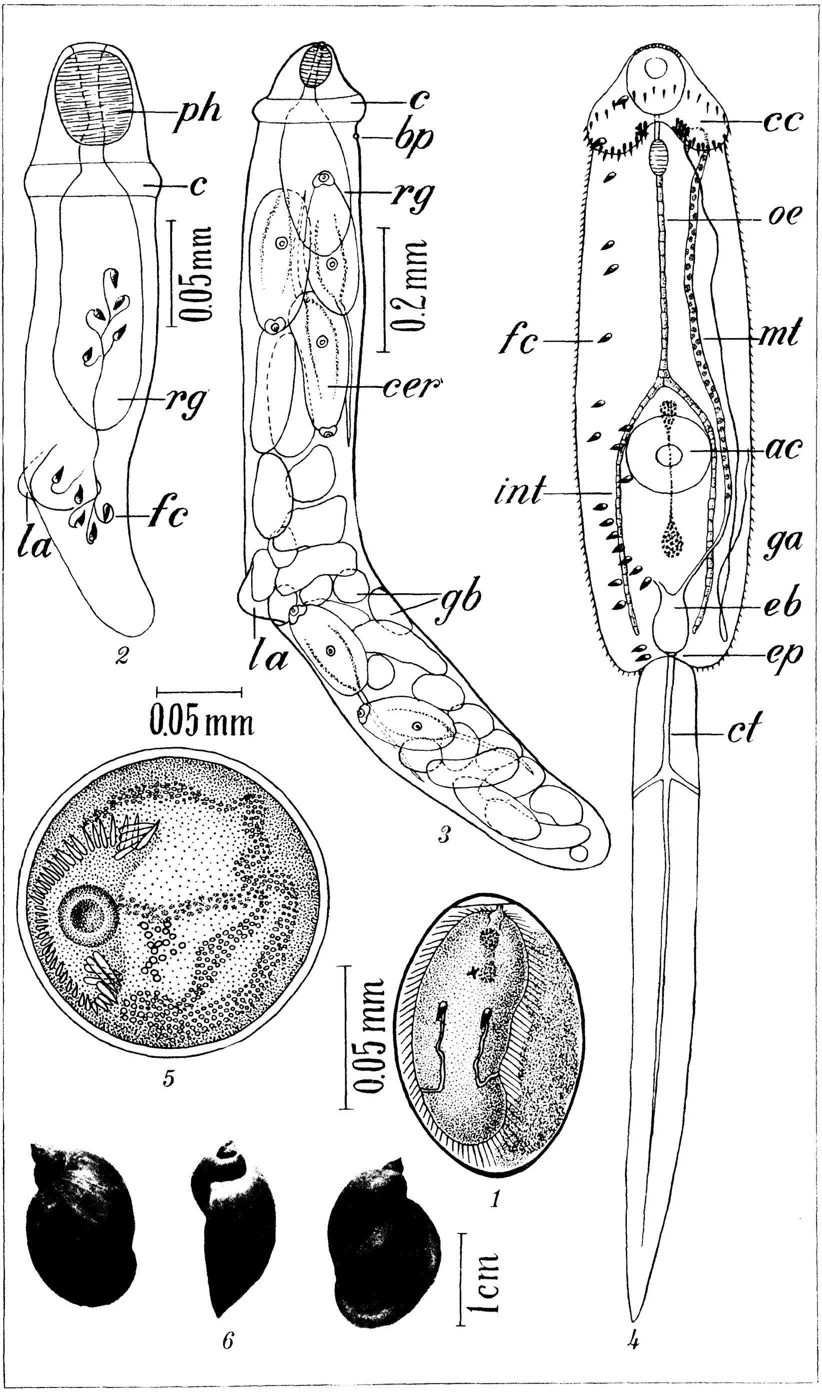
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PLATE 2.

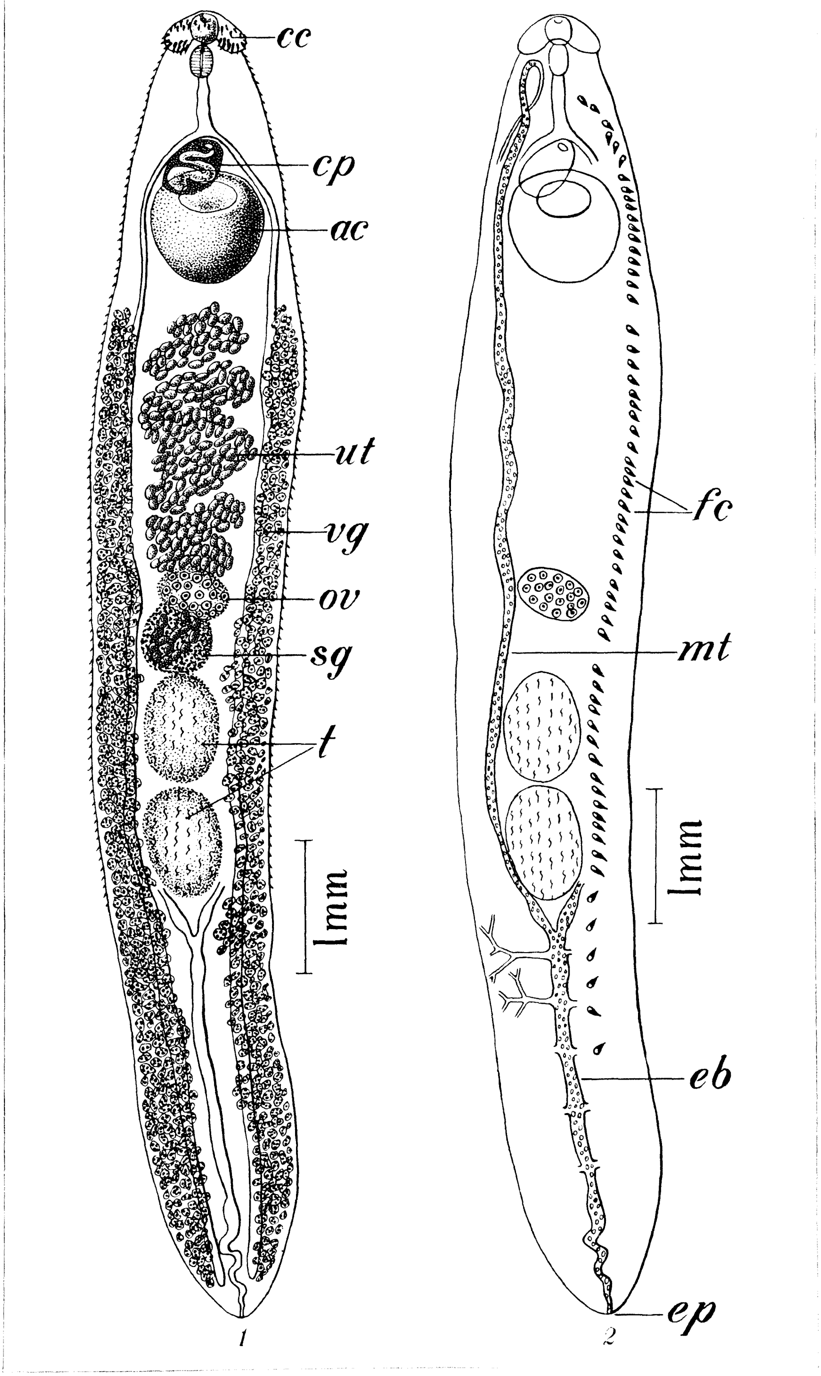


PLATE 3.

NEUE STAPHYLINIDEN (COLEOPTERA) DER PHILIPPINEN

3. BEITRAG ZUR KENNTNIS DER STAPHYLINIDEN

Von ALEXANDER BIERIG

Habana, Cuba

EINE TAFEL

Die nachfolgend als neu beschriebenen und abgebildeten Staphyliniden der Gattung *Eleusis* Castelnau befanden sich unter anderen in einer freundlichst für mich gemachten Aufsammlung des Entomologen Herrn Fred C. Hadden, Agricultural College, Laguna, Luzon, dem ich eine Art dankbar widme. Ich behalte mir vor, weitere, neue Arten aus genannter Familie und dem gleichen Faunengebiet spaterhin am selben Orte zu veröffentlichen.

Schon über dreizig Arten dieser Gattung sind vom Inselreich der Philippinen bekanntgemacht. Dass nun von sieben erbeuteten Arten fünf sich als neu erwiesen, spricht dafür, dass diese Gattung dort recht artenreich zu sein scheint, und sicher noch weitere Vertreter zu erwarten sind.

Den Beschreibungen sei Folgendes vorausgeschickt: Die gemachten Angaben über Massverhältnis der einzelnen Körperteile beziehen sich nicht auf (oft täuschendes) Augenmass, sondern auf wirkliche, möglichst genaue Messung, wie sie zur Herstellung der Habitusbilder nötig war. Relative Bemerkungen—ohne vergleichenden Masstab—wie zum Beispiel: "Fühler ziemlich lang" oder "ziemlich kurz," die in Neubeschreibungen regelmässig wiederkehren, suche ich zu vermeiden. Sie ermöglichen keine klare Vorstellung und können zu Täuschungen führen, wenn es sich um sehr ähnliche Tiere einer Sippe handelt, was recht oft der Fall ist. Und je mehr sich die Artenzahl einer Gattung vergrössert, desto wichtiger sind positive und fassliche Angaben der Grössenverhältnisse der verschiedenen Körperteile zueinander—wenn das Behandelte Bausteine sein sollen, anstatt "Hemmschuhe."

ELEUSIS AUGUSTÆ Bernhauer.

Eleusis augustæ BERNHAUER, Philip. Journ. Sci. 31 (1926) 247.

Die Körperlänge dieser Art, die mit 7.5 bis 8.5 mm fixiert ist, beträgt bei weiblichen Individuen oft nur 6.5 mm, bei normal gestrecktem Leib.

Hab. Mount Santo Tomas, 6,500 Fuss, 26. März 1931.

ELEUSIS BELUA sp. nov. Tafel 1, Fig. 1.

Der *E. angusticeps* Bernhauer [1] nahestehend. Von ihr durch doppelte Körperlänge, kürzere Fühler, mehr einheitlich dunkle Färbung, zwei Gruben auf der hinteren Halsschildpartie und so weiter verschieden.

Glänzend, bräunlichschwarz, Vorderrand des Kopfes, Mund, Fühler, Taster, Beine, Schultern und Hinterränder der Dorsalsegmente des Abdomens rotbraun. Grundskulptur sehr deutlich, kaum verworren, mit eingestreuten, tiefen Pünktchen, die auf dem Abdomen fehlen.

Lange 4.5 bis 5 mm.

Kopf gross, wenig länger als breit, parallelseitig mit runden Hinterecken; hinter dem Stirnhöcker (auf der Höhe des Augenvorderrandes) ist bei entsprechendem Lichteinfall oft jederseits eine flache Grube sichtbar; in der Mitte schmal gefurcht, die Furche hinten in einer breiten, rundlichen Depression vor dem Halse endend. Augen klein, Schläfen drei Mal grösser als der Augen Längsdurchmesser; die lange Furche über dem Auge reicht bis an die Rundung der Hinterecken und endet in einem borstentragenden Porenpunkt. Fühler nur ganz wenig länger als der Kopf (ohne die Mundwerkzeuge), Glied 3 wenig kürzer als 2, die vorletzten Glieder so lang wie breit.

Halsschild vorn wenig schmäler als der Kopf, wenig breiter als lang, am Vorderrand jederseits nahe den Ecken eine Gruppe von drei gleichweit entferntstehenden Pünktchen in einer Grube, Seiten Zähnchen scharf; eine sehr feine Mittellinie zieht nicht ganz bis zum Halse vor, in der hinteren Hälfte liegt jederseits eine breite, mässig tiefe Grube.

Flügeldecken etwas breiter als der Kopf, fast so lang wie breit, vorn wenig schmäler als hinten; der übliche Punkt auf jeder Decke ist sehr klein und kaum wahrnehmbar, und ein ebensolcher Punkt ist oft im vordern Viertel sichtbar.

[1] Philip. Journ. Sci. 31 (1926) 249.

Leib etwas schmäler als die Decken, hinten wenig breiter als vorn, die seitlichen Porenpunkte auf den Segmenten flach.

Die Grundskulptur verläuft am Kopf vorn in U-form, auf seiner Scheibe, longitudinal, ebenso längs der Mitte des Halsschildes und auf den Flügeldecken; auf dem Abdomen zieht sie wellig quer.

Beim ♀ verrunden die Schläfen in flachem Bogen zum Hals; der Kopf ist dadurch mehr eiförmig.

Sechs Exemplare wurden eingesammelt, die zum Teil in schlechtem Zustand sind.

Hab. Mount Data, 7,000 Fuss, 16. März 1931.

Type (♂), Para- und Cotypen in meiner Sammlung.

(Die Zeichnung ist nach der Type angefertigt.)

ELEUSIS HADDENI sp. nov. Tafel 1, Fig. 2.

Der Beschreibung nach dürfte diese Art mit *E. speculiceps* Bernhauer [2] verschiedene Berührungspunkte haben, wie zum Beispiel lange, schlanke Fühler und Halsschild ohne deutliches Seitenzähnchen. Die Verschiedenheit ist aber doch gross und liegt unter anderm in der sichtbaren Grundskulptur, mehr Körpergrösse und scheinbar dunkleren Flügeldecken.

Glänzend, pechschwarz, Mund und Beine hellrotbraun; Fühler von der Spitze des ersten Gliedes an bräunlichrot; Schenkel dunkler, hinterrand der Segmente rötlich durchscheinend, Verbindungshaut hellgelb (falls sichtbar). Flügeldecken bräunlichgelb; Naht, Seiten- und Hinterrand dunkel. Grundskulptur sehr fein und flach mit wenigen, zarten, eingestreuten Pünktchen, auf dem Leib fast erloschen.

Länge 5.5 mm, bei etwas ausgezogenem Hinterleib.

Kopf rundlich viereckig, etwas breiter als lang, mit vorgewölbten, mit dem Hals verrundeten Schläfen, die zwei Mal so lang sind, wie der Augen Längsdurchmesser. Fühlerbeulen breit, Furche über dem Auge doppelt so lang wie dieses. Linke Mandibel mit deutlichem Innenzahn versehen, Fühler so lang wie der Kopf (ohne den Mund) und Halsschild, alle Glieder ziemlich länger als breit.

Halsschild so breit wie der Kopf, ohne seitliche Einkerbung, an Stelle des üblichen Zähnchens auf einer kleinen Unebenheit nur ein borstentragender Porenpunkt, innerhalb der Vorderecken

[2] Philip. Journ. Sci. 31 (1926) 250.

in einer Grube zwei Punkte, längs der Mitte fein gefurcht, Furche weder den Vorder- noch den Hinterrand berührend, Scheibe leicht niedergedrückt.

Flügeldecken wenig breiter als der Kopf, so lang wie hinten breit, vorn wenig schmäler und mit geraden Seiten, der Punkt auf jeder Decke deutlich.

Abdomen nicht ganz so breit wie die Flügeldecken, von der Mitte an verjüngt, die seitlichen Punkte ziemlich scharf.

Die Grundskulptur verläuft am Kopf über der Stifnbeule wagerecht, über den Augen) (-förmig, vor dem Hals Ωförmig; in der Halsschildmitte dachformig (doch fast rechtwinkelig zur Mittellinie); auf dem ersten Flügeldeckendrittel von der Schulter zur Mitte der Naht, dann mehr in Längsrichtung; am Abdomen wellig quer.

Ein Exemplar als Type in meiner Sammlung, scheinbar ein ♂.

Hab. Mount Maquiling, 400 Fuss, Laguna.

ELEUSIS PALAWANENSIS Bernhauer.

Eleusis palawanensis BERNHAUER, Philip. Journ. Sci. 31 (1926) 249.

Ein Exemplar vom Mount Maquiling deckt sich mit der kurzen Beschreibung dieser Art. Leider ist nichts über das charakteristische Seitenzähnchen des Halsschildes gesagt, das bei meinem Individuum recht klein aber deutlich ist.

ELEUSIS DERIVATA sp. nov. Tafel 1, fig. 3.

Der grossen Augen wegen scheint diese Art der *E. crassicornis* Bernhauer [3] nahe zu stehen. Wahrscheinlich sind die Augen sogar grösser, die Fühler im Gegensatz lang, der Käfer ist grösser und dunkler gefärbt.

Sehr glänzend, rötlichbraun, der Kopf, die hinteren zwei Drittel der Flügeldecken und das vorletzte Dorsalsegment schwärzlich, Mund, Fühler, Schulterpartie der Flügeldecken, Beine und die hintere Hälfte der Segmente eine bis einschliesslich vier hell rötlichgelb, der Hinterrand des 5. und des 6. (letzte) Segment rötlich. Grundskulptur sehr zart und fein, am Abdomen bein 35 maliger Lupenvergrösserung gerade noch bemerkbar, die eingestreuten Pünktchen—am Vorderkörper—deutlich.

Länge 3 bis 4 mm.

Kopf quer rundlich, etwas kürzer als breit, breiter als der Halsschild, an der Fühlerwurzel breiter als an den Schläfen, vor dem Hinterrand der Quere nach leicht eingedrückt; Augen

[3] Philip. Journ. Sci. 31 (1926) 250.

gross und vorquellend, Schläfen sehr klein kürzer als der daran anschliessende, dicke, konische Hals. Fühler so lang wie Kopf (einschliessend dem Mund) und Halsschild, die vorletzten Glieder wenig länger als breit.

Halsschild ein Viertel breiter als lang, Seiten erst eine kurze Strecke gerade, dann sanft verrundet, Seitenzähnchen hinter einer sehr schwachen Kerbe leicht angedeutet, innerhalb der Vorderecken erscheint im richtigen Licht neben einer Unebenheit ein kleiner Punkt, Scheibe abgeplattet.

Flügeldecken an den Schultern so breit wie der Kopf und fast rechtwinkelig, nur wenig länger als breit, der Punkt auf jeder Decke scharf eingestochen.

Leib bis zum vorletzten Segment parallel und etwas weniger breit als die Flügeldecken. Borstenpunkte längs der Seiten deutlich.

Die feine Grundskulptur des Kopfes verläuft auf dem Stirnhöcker quer, seitlich)(-förmig, hinter dem hinteren Eindruck quer; die der Halsschildmitte läuft spitz dachgiebelförmig; auf den Decken zieht sie fast longitudinal, am Abdomen unklar und verworren quer.

Beim ♀ scheint der ganze Vorderkörper geringer zu sein.

Eine Anzahl Individuen vom genannten Orte.

Hab. Mount Santo Tomas, 6,500 Fuss, 26. März 1931.

Type (♂) und Paratypen in meiner Sammlung, Cotypen in der Haddenschen und meiner eigenen.

(Die Zeichnung ist nach den Massverhältnissen der Type hergestellt.)

ELEUSIS SEMISPLENDIDA sp. nov. Tafel 1, fig. 4.

Von habitueller Ähnlichkeit mit der *E. derivata* m. Doch sind die Augen kleiner, die Zähnchen seitlich am Halsschild deutlich, das ganze Tier grösser, am Vorderkörper scharf nadelrissig skulptiert, und das letzte Dorsalsegment ist schwarz.

Glänzend schwarz; Mund, Fühler, Beine, erste Drittel der Flügeldecken und das hintere Drittel der Abdominalsegmente (oben) hell bräunlichrot, die Schenkel angedunkelt. Die in die Grundskulptur eingestreuten Pünktchen sind deutlich und ziemlich regelmässig aufgeteilt; sie sind am Abdomen kaum bemerklich.

Länge 5 mm, bei wenig ausgezogenem Leib.

Kopf rundlich viereckig, so lang wie breit, an der Fühlerwurzel etwas enger als an den Schläfen, Augen mässig gross, von oben besehen so gross wie die Schläfen, Hinterecken stumpf

gerundet, Hals dick und wie bei der vorherigen und der folgenden Art als Konus aus dem Halsschild ragend, über dem Hals in einer rundlichen und flachen Erhabenheit eine seichte Einsenkung. Mundwerkzeuge auffallend klein, Fühler so lang wie Kopf (ohne Mund) und Halsschild, alle Glieder länger als breit.

Halsschild wenig schmäler als der Kopf, kaum etwas breiter als lang, erst ein gutes Stück parallelseitig, dann bis zu dem scharf vorspringenden Zähnchen eingebogen, von da mit dem Hinterrand verrundet. Scheibe platt und leicht eingedrückt, hinten mit glatter, schmaler Längszone (wie ein abgeschliffener Kiel). Dicht neben einem deutlichen, stumpfen Zähnchen innerhalb der Vorderecken sitzen zwei Porenpunkte, von denen der äussere der grössere ist.

Flügeldecken an den Schultern so breit wie der Kopf am Augendurchmesser, im zweiten Drittel nach sanfter Auswärtsrundung etwas breiter, so lang wie breit, der eingestochene Punkt wenig tief aber deutlich.

Leib nicht ganz so breit wie die Flügeldecken und fast ganz gleichbreit, etwas flacher, als es bei andern Arten der Fall zu sein pflegt; seitliche Porenpunkte sehr leicht.

Die Grundskulptur ist in der Mitte des Kopfes verworren längsgerichtet, ganz vorn quer; am Halsschild und den Flügeldecken der Längenachse folgend, nicht ganz so sehr verworren und weniger scharf; auf den Leibesringen befindet sich eine lederartig schuppige Körnelung, wodurch sie matten Glanz erhalten.

Ein einziges Exemplar als Type in meiner Sammlung; das Geschlecht lässt sich nicht mit Sicherheit feststellen.

Hab. Mount Santo Tomas, 6,500 Fuss, 26. März 1931.

ELEUSIS MULTIZONATA sp. nov. Tafel 1, Fig. 5.

Diese niedliche Art ist sehr auffallend durch die vom 4. Glied an schwarzen, lose gegliederten Fühler mit hellgelben Verbindungsstielchen. Das Abdomen ist aussergewöhnlich breit.

Sehr glänzend, rötlichgelb; Kopf und die letzten sieben Fühlerglieder schwarz, die hinteren drei Fünftel der Flügeldecken, die vorderen zwei Drittel der Sternite (das letzte gänzlich) braun, die Verbindungshaut der Sternite weiss. Die feine Grundskulptur ist bei 35 maligern Lupenvergrösserung noch wahrnehmbar, und spährlich eingestreute Punkte treten deutlich hervor.

Länge 2.5 mm, bei ausgezogenem Leib.

Kopf rundlich, mit den Augen wenig breiter als ohne den Mund lang, an den Fühlerwurzeln nicht so breit wie an den Schlafen, diese ungefähr so lang wie Augen; plattgedrückt, hinten etwas erhaben über den Hals gezogen (ähnlich wie bei *E. semisplendida* m.), Hals breit, konisch und verragend; Fühler so lang wie Kopf und Halsschild, die vorletzten Glieder wenig quer.

Halsschild fast um ein Drittel breiter als lang, seitlich in einem Zug gerundet und mit kaum merklicher Einkerbung an der Stelle des sonst üblichen Zähnchens, Scheibe wenig eingedrückt. Innerhalb der Vorderecken kein Eindruck und nur ein kleiner Porenpunkt daselbst.

Flügeldecken fast parallelseitig, so breit wie der Kopf, ein Fünftel länger als breit, der eingestochene Punkt ausserst klein.

Abdomen von der Basis bis zum 3. Segment so breit wie die Flügeldecken (oder wenig breiter), seitliche Porenpunkte sichtbar.

Der Verlauf der kaum sichtbaren Grundskulptur dürfte bei dieser sonst so auffallenden Art von nur untergeordneter Bedeutung sein.

Drei Exemplare wurden eingesammelt, wovon zwei unreif, beim Trocknen eingesunken und auch sonst in schlechtem Zustand sind; sie befinden sich in meiner Sammlung.

Hab. Mount Santo Tomas, 6,500 Fuss, 26. März 1931.

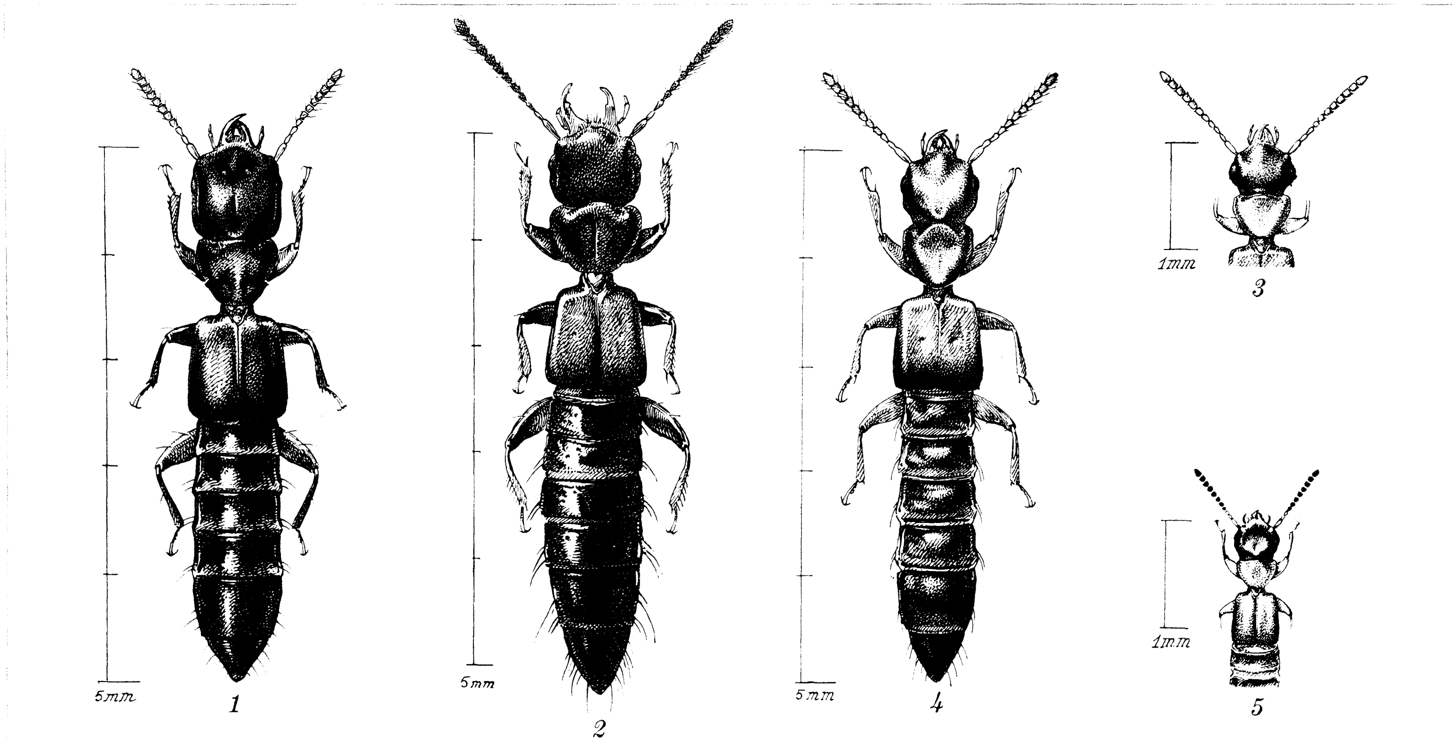
Type, ♂ (?); nach ihr ist die Zeichnung gemacht.

266903——7

ABBILDUNGEN

TAFEL 1

FIG. 1. *Eleusis belua* sp. nov., ♂.
2. *Eleusis haddeni* sp. nov., ♂?
3. *Eleusis derivata* sp. nov., ♂.
4. *Eleusis semisplendida* sp. nov.
5. *Eleusis multizonata* sp. nov.



TAFEL 1.

RUBBER CONTENT OF PHILIPPINE PLANTS, I: FICUS

By JOAQUIN MARAÑON
Of the Bureau of Science, Manila
and
PACITA CABATO
Of the Department of Botany, University of the Philippines

Due to the ever-increasing demand for rubber in the world's market, the search for rubber-producing plants is a problem of considerable interest. This is particularly true in countries where owing to climatic conditions and soil characteristics the question of finding a satisfactory substitute for the heveas, the plants that furnish the greatest bulk of natural rubber consumed by the industries of the world, has been the subject of speculation and research.

The investigations have produced significant results, since various plants are now known that can be utilized as commercial sources of the raw material and great possibilities are believed to exist in some of these. Thus, according to a recent report,[1] the late Thomas Alva Edison, the famous electrical wizard, had succeeded in growing a 12-foot rubber-yielding goldenrod (*Solidago*) after raising and cross-breeding thousands of plants within the last few years in his experimental station at Fort Myers, Florida. The guayule plant (*Parthenium argentatum* A. Gray), which grows wild on the deserts of the Mexican and the American border and which in 1904 rose to a price of 75 dollars per ton incident to the industrial exploitation of the plant for rubber in Mexico,[2] is now extensively cultivated at Salinas, California, and in some parts of the western United States. According to Hall and Goodspeed,[3] who made a rubber-plant survey of western North America, it seems probable that not less than 300,000,000 pounds of chrysil, a new rubber from *Chrysothamnus nauseosus*, can be produced from this shrub in

[1] Pop. Sci. Month. 118 No. 4 (April, 1931) 32.
[2] Standley, P. C., Contr. U. S. Nat. Herb. 23 pt. 4 (1924) 1520.
[3] Univ. Calif. Publ. Bot. 7 (1919) 210.

all of the Western States. These possibilities are significant, particularly to the United States where the industrial requirement is about 80,000,000 pounds of rubber per month.[4] The Ceara caoutchouc tree (*Manihot glaziovii* Muell.-Arg.) a South American species, which is now acclimatized in Congo, Ceylon, German East Africa, and the Philippines; the castilloas of Central America; the kickxias of the African west coast; and some of the milkweeds are other plants promising rubber production in commercial quantities.[5]

In the Philippines, the three rubber plants that are being cultivated on a commercial scale are the Para (*Hevea brasiliensis* Muell.-Arg.), the Ceara (*Manihot glaziovii* Muell.-Arg.), and the castilloa (*Castilloa elastica* Cerv.). Due to the fertile soil and the warm climate these plants thrive well in various regions of the Archipelago, especially in the southern part outside of the typhoon belt. Also under these favorable tropical conditions there are various latex-producing plants growing abundantly everywhere.

However, very little is known as to their industrial possibilities; it is, therefore, interesting to know which of them contain rubber. With this aim in view investigation was begun. The fact that there are several species of *Ficus* widely distributed in the Islands at once suggested that it would be advisable to begin the study with this genus. Furthermore, as can be seen from Table 1, many species of *Ficus* containing rubber are already known in other countries; obviously, it would be of interest to compare the extent of the occurrence of rubber in Philippine *Ficus* plants with that in the foreign ones.

In searching for previous work on rubber, as reported in the Philippines, but few references directly relating to the chemical aspect of the problem were found. However, there are some interesting papers dealing with phases presented by the cultivation of rubber plants. For instance, Worcester[6] has discussed at length the cultivation, propagation, and tapping of Ceara and Para rubber plants in the southern Philippine Islands. In this article, the land laws and the estimates of expense and profit in connection with the cultivation of rubber plants are also given. Aldaba[7] has made an interesting botanical study of the culti-

[4] Scientific Monthly (November, 1928) 413.

[5] Clouth, F., Rubber, Gutta-percha and Balata. First English translation (1903) 30–55.

[6] Far Eastern Rev. 9 No. 2 (1912) 131.

[7] Philip. Agr. 7 (1919) 274.

vation and tapping of castilloa rubber in the Philippines, where environmental and soil conditions, methods of culture, clearing, pests, diseases affecting the plant, tapping, and improvement by selection are among the many points discussed.

Manas [8] and Elayda [9] have tested the germination of the seeds of rubber plants that were mostly of foreign origin. Among the plants tested were *Manihot dichotoma* Ule, *M. piacuyensis* Ule, *M. heptaphylla* Ule, *Marsdenia verrucosa* Decne, *Mimusops balata* Blume, *Cryptostegia madagascariensis* Boj., and *Marsdenia verrucosa* Decne.

In his anatomical study of the laticiferous vessels in *Hevea brasiliensis*, Quisumbing [10] states that these vessels occur in the pith in young stems and in seedlings and also in the leaves and roots. He further observes that the latex tubes originate from the cambium in the secondary cortex, within the stone ring; or from the primary cortex and phellogen, outside of the stone ring.

Of further interest to the public and in particular to rubber planters in the Philippines are the works of Sarmiento,[11] Hester,[12] Muzzal, [13] Mendiola,[14] and Tamesis.[15] In these papers, important problems relative to the cultivation of rubber in the Islands are presented. Besides these publications, there are the monthly bulletins of the Bureau of Commerce and Industry and the annual reports of the Bureaus of Agriculture and Forestry of the Philippine Government, which are among the best sources of information on the progress of rubber planting in the Islands.

So far as known, the Philippine latex plants that have been chemically examined for rubber or gutta-percha are the "tagulaoay" (*Parameria philippinensis*, Radlk.), "dita" [*Alstonia scholaris* (Linn.) R. Br.], "palakpalak" [*Palaquium philippense* (Perr.) C. B. Rob.], and *Micrechites schrieckii* (Van Huerck and Muell.-Arg.) Rolfe. In the first plant, Bacon [16] found that the bark contains 4 to 5 per cent of rubberlike gum, but he believes that the commercial utilization of this rubber vine is very doubt-

[8] Philip. Agr. & For. 1 (1911) 118.

[9] Philip. Agr. & For. 2 (1912) 28.

[10] Univ. Calif. Pub. Bot. 13 (1927) 319.

[11] Philip. Agr. 5 (1916) 159.

[12] Philip. Agr. 12 (1923) 43.

[13] Makiling Echo 3 No. 4 (1924) 9; 4 No. 4 (1925) 2.

[14] A Manual of Plant Breeding for the Tropics. Chapter XI. Bureau of Printing, Manila (1926).

[15] Makiling Echo 5 No. 1 (1926) 18; No. 2, 13.

[16] Philip. Journ. Sci. § A 4 (1909) 166.

TABLE 1.—*Foreign species of Ficus reported to contain rubber.*[a]

Species.	Local name.	Where found.			
		America.	Africa.	Asia.	Australia.
Ficus altissima Blume				Sumatra, Java	Australia.
Ficus annulata Blume				Pegu, Siam, Malacca	
Ficus crassinervia Desf		Guadeloupe			
Ficus elastica Roxb	Karet, karet-tapok, pohon-karet, kohlet.			Bengal, Prince of Wales' Islands, Malacca, Cochin-China, Annam, Tonkin, Java.	
Ficus glomerata Roxb				British India	
Ficus holstii Warb	Msoso		German East Africa		
Ficus incisa Wall	Banian				New Caledonia.
Ficus indica Linn	Cashmir, banjan			Bengal, Assam, Burma, Singapore, Siam, Malacca, Philippines.	
Ficus laccifera Roxb	Hyoung-pen			Assam, Pegu, Siam	
Ficus lentiginosa Vahl		Guadeloupe			
Ficus macrophylla Roxb				Java, Sumatra, Indian Archipelago.	Australia.
Ficus medina Kahl			Senegambia, Soudan.		
Ficus obtusifolia Roxb	Hyoung-hyap			Chittagong, Siam, Malacca	
Ficus oppositifolia Willd				British India	
Ficus pertusa Linn		Guadeloupe			
Ficus prinoides Humb. and Bonpl	Banut-kalodja				
Ficus racemosa Wall			South of the Ivory coast.		
Ficus radula Willd		Venezuela			
Ficus religiosa Linn				Bengal, Java	

Ficus rubiginosa Desf				Java, Sumatra, Indian Archipelago.	Australia.
Ficus subcalcarata Warb					
Ficus tammako	N'daba touronim koko, n'zéne touron.		Senegambia, Soudan		
Ficus trichopoda Baker			Madagascar		
Ficus usambarensis Warb			German East Africa		
Ficus vogelii Miq	Aba		Gold Coast		

[a] Clouth, Franz, Rubber, Gutta-Percha and Balata, first English translation (1903) 16–20.

TABLE 2.—*Chemical analyses of stems and leaves of Ficus.*

[Based on moisture-free samples.]

Species.	Local name.	Place of collection.	Part used.	Acetone extract.	Benzene extract.
				Per cent.	*Per cent.*
Ficus ampelos Burm	Malaisís	Makiling Botanic Garden, Laguna	Leaves	8.20	0.02
			Bark of stem	3.26	0.11
Ficus balete Merr	Baléte-pulá	do	Leaves	13.04	0.06
			Bark of stem	6.83	0.09
Ficus barnesii Merr	Tibig, tagkulabas	do	Leaves	6.11	0.01
			Bark of stem	4.37	0.07
Ficus calophylloides Elm	Baléte, tibi	Manila	Leaves	7.79	0.08
			Bark of stem	19.71	0.73
Ficus cassidyana Elm	Tambon, tubog	Makiling Botanic Garden	Leaves	7.83	0.01
			Bark of stem	3.43	0.08
Ficus celebica Blume	Takines, maladaliket	do	Leaves		
			Bark of stem	2.58	0.06
Ficus conora King	Basikong	do	Leaves	14.25	0.07
			Bark of stem	6.51	0.05
Ficus cuernosensis Elm	Tabúgai, tabog	do	Leaves	19.29	0.04
			Bark of stem	6.63	0.06
Ficus elastica Roxb		do	Leaves	11.20	0.11
			Bark of stem	12.46	3.56
Ficus hauili Blanco	Hauíli, lagmut	Manila	Leaves	6.48	0.08
			Bark of stem	4.71	0.07
Ficus irisana Elm	Pilí-na-dakó	Makiling Botanic Garden, Laguna	Leaves	8.38	0.07
			Bark of stem	1.68	0.06
Ficus malunuensis Warb	Bugarila, kalukoi	do	Leaves	9.81	0.06
			Bark of stem	1.50	0.05
Ficus manilensis Warb	Uplás, butlí	do	Leaves	5.66	0.09
			Bark of stem	3.85	0.08

Ficus minahassae (Teysm. and De Vr.) Miq	Hagúmit	Manila	Leaves	8.18	0.02
			Bark of stem	5.09	0.52
Ficus nervosa Heyne	Kanápai, tagitig	Makiling Botanic Garden	Leaves	23.44	0.03
			Bark of stem	2.71	0.10
Ficus nota (Blanco) Merr	Tebel, tuyokai	Manila	Leaves	11.10	0.02
			Bark of stem	14.27	0.02
Ficus odorata (Blanco) Merr	Agosos	Makiling Botanic Garden, Laguna	Leaves	11.79	0.03
			Bark of stem	2.95	0.10
Ficus payapa Blanco	Payápa	Manila	Leaves	12.87	0.02
			Bark of stem	3.54	0.06
Ficus philippinensis Miq	Diákit, tayabas	do	Leaves	4.99	0.08
			Bark of stem	12.63	0.10
Ficus pisifera Wall	Isís ligau, pilig	Makiling Botanic Garden, Laguna	Leaves	11.57	0.02
			Bark of stem	2.19	0.07
Ficus pseudopalma Blanco	Niog-niog, lubi-lubi	do	Leaves	9.97	0.06
			Bark of stem	2.28	0.05
Ficus pubinervis Blume	Deudéu, duugo	do	Leaves	15.76	0.07
			Bark of stem	2.45	0.10
Ficus ulmifolia Lam	Isís, hagupít	Manila	Leaves	8.57	0.03
			Bark of stem	2.32	0.10
Ficus variegata Blume	Laptái, tabgón, tubol	Makiling Botanic Garden, Laguna	Leaves	5.95	0.02
			Bark of stem	6.79	0.07

ful. In the case of the other plants, analyses made by the American Chicle Company [17] show that they contain gutta percha, although it is doubted whether the gum can be of much value in the chewing-gum industry.

In this report, twenty-four species of *Ficus* were examined.[18] Thirteen of these are endemic and the rest are either introduced species or Pantropic in cultivation. The species that were found to contain rubber are *Ficus minahassae* (Teysm. and De Vr.) Miq., *F. elastica* Roxb., and *F. calophylloides* Elm. The rubber extracted from the above-mentioned species was found to agree closely in its percentage composition with the hydrocarbon of the formula $C_{10}H_{16}$ which is the greatly preponderating constituent of Para rubber.

EXPERIMENTAL

The material consisted of stems and leaves of *Ficus* which were obtained from the neighborhood of Manila and from the Makiling Botanic Garden,[19] Agricultural College, Laguna. The leaves and the bark of the stems were air-dried and ground to pass through a 20-mesh sieve. Moisture determinations of the different powdered samples were made and the results of the analyses expressed in terms of the moisture-free basis.

For the determination of rubber in the samples, the method recommended by Hall and Goodspeed [20] was adopted. The acetone extraction, however, was prolonged for more than three hours since it was found that the coloring matter could not be removed in this period of extraction as prescribed in the original method.

From Table 2, it can be seen that the major portion of the gummy constituent of the latex is removed by the acetone extract which represents approximately all the resins, fats, and coloring substances. In the benzene extract which contains rubber, only three species of *Ficus* were found to give an appreciable residue. These are *F. calophylloides* Elm., *F. elastica* Roxb., and *F. minahassae* (Teysm. and De Vr.) Miq. The per cent of rubber in

[17] Makiling Echo 9 No. 4 (1930) 38.

[18] The writers are deeply appreciative of the help rendered by Dr. E. Quisumbing, of the Bureau of Science, in the identification of these species.

[19] The writers wish to express their thanks to Prof. Carlos Sulit and Mr. Mamerto Sulit, of the School of Forestry, University of the Philippines, for their kindness in supplying some of the samples used in this investigation.

[20] Univ. Calif. Pub. Bot. 7 (1919) 216.

the bark of the stem of these plants is 0.73, 3.56, and 0.52, respectively. The amount of rubber thus obtained, however, is subject to fluctuation as there are several factors, such as the age of the plant, soil and climatic conditions, which must necessarily affect the yield of rubber in a given plant. While the other samples analyzed show that there is a small amount of benzene extract, this may be due to the resinous matter which was not completely removed by acetone. Moreover, the amount of the extract is such that the presence of rubber in them is doubtful.

From the elementary composition [21] of the rubber obtained from the above-mentioned plants, as shown in Table 3, the percentage composition of the hydrocarbon agrees very closely with that reported for Para and India rubber.

TABLE 3.—*Ultimate analysis of rubber from Philippine Ficus.*

Species.	Carbon.	Hydrogen.	Oxygen 100—(C+H).	Carbon : Hydrogen.
	Per cent.	*Per cent.*	*Per cent.*	
Ficus minahassae	87.16	11.85	0.99	10 : 16.18
Ficus elastica	86.40	12.00	1.60	10 : 16.52
Ficus calophylloides	85.70	11.92	2.38	10 : 16.41

SUMMARY

Chemical analyses of twenty-four species of Philippine *Ficus* for the rubber content was performed. These species were collected from the vicinity of Manila and from the Makiling Botanic Garden, Agricultural College, Laguna.

The species which were found to contain rubber are *F. calophylloides* Elm., *F. elastica* Roxb., and *F. minahassae* (Teysm. and De Vr.) Miq. The percentages of rubber found in the stems of these plants are 0.73, 3.55, and 0.52 respectively.

From the elementary analysis, the rubber obtained from the above-mentioned species contains the hydrocarbon of the formula C_{10} H_{16} which is the prevailing constituent of Para rubber.

[21] The writers are indebted to Dr. Alfredo Santos, School of Pharmacy, University of the Philippines, for the microelementary analysis of the rubber samples.

STUDIES AND ILLUSTRATIONS IN THE POLYPORACEÆ, II

FOMES PACHYPHLOEUS PATOUILLARD AND FOMES MAGNOSPORUS LLOYD [1]

By C. J. HUMPHREY

Mycologist, Bureau of Science, Manila

and

SIMEONA LEUS

Junior Mycologist, Bureau of Science, Manila

TEN PLATES

Fomes pachyphloeus is quite common in the Philippines and is so distinctive in structure that it can easily be separated from all other members of the genus. Its closest relative is *Fomes magnosporus* Lloyd, (15) from which it differs structurally in the distribution and abundance of the characteristic seta-like hyphæ in the context, the presence of small setæ in the pores, and the smaller spores. It is of wide distribution in the Tropics. Bresadola(4) reports it from Suriman, South America. In Africa it is recorded by Bresadola(2, 4) and Patouillard(20) from the Kamerun, by Wakefield(28) from Nigeria, by Deighton(7) from Sierra Leone, by Patouillard and Hariot(25) from Senegal, and by Lloyd(17) without giving locality. It is also reported from Madagascar(14) and Mauritius(13) by Lloyd. It was originally described from Fiji(20) by Patouillard. Parks(19) finds it in Tahiti. Both Bresadola(3) and Lloyd(12) report it from Java. In Indo-China Patouillard lists it from Annam, (24) from Cambodia, (22) and from Tonkin. (23) Two specimens have also been received from the Federated Malay States. From the Philippine Islands it is recorded by Bresadola, (4, 5) by Graff, (9) by Lloyd, (16) and by Reinking. (27)

[1] The first paper of this series is one by the same authors entitled, "A partial revision of the Ganoderma applanatum group, with particular reference to its Oriental variants," Philip. Journ. Sci. 45 (1931) 483–589.

HOSTS AND ECONOMIC IMPORTANCE

It is a vigorous wood-destroyer found frequently on dead standing trees and fallen trunks in the forest and occasionally producing extensive heart rot in mature or overmature living trees, having a preference in the Philippines for the more perishable species. Ten hosts have so far been identified in the Philippines; namely, *Albizzia procera* (Roxb.) Benth., *Ficus* sp. [Reinking(27)] *Hopea acuminata* Merr., *H. philippinensis* Dyer, *Parashorea malaanonan* (Blco.) Merr., *Parkia javanica* (Lam.) Merr., *Pentacme contorta* (Vid.) Merr., *P. mindanensis* Foxw., *Rhizophora candelaria* DC., *R. mucronata* Lam., *Shorea guiso* (Blco.) Blm., and *Shorea* sp.

In addition to these records Deighton(7) and Patouillard and Hariot(25) report it on *Parinarium excelsum* in West Africa, Parks(19) on an old mango in Tahiti, and Faris(8) reports a *Fomes*, perhaps *F. pachyphloeus*, as a possible cause of the "zonate foot rot" of sugar cane in Cuba.

TAXONOMY AND SYNONYMS

The fungus was originally described in August, 1899, by Patouillard(20) from Fiji, as *Polyporus pachyphloeus*, with the citation also of a specimen from Kamerun which Bresadola redescribed the following year and of which he gave a colored illustration. In 1900, Patouillard(21) transferred it to Quélet's genus *Phellinus* erected four years earlier(26) on the following characters: "Pileus velutinus, persistens. Caro suberosa. Pori parvi, fulvo-brunnei. Spora ovoidea, fulva. Lignatiles." This genus has been used, mostly by French mycologists, for certain species formerly placed in *Fomes*, *Polyporus*, and *Poria*. In fact, the genus *Fomes* was not recognized at all in Quélet's Enchiridion or Patouillard's Essai Taxonomique and does not find a place even in the most modern work on French fungi by Bourdot and Galzin.(1)

In 1917, Murrill(18, p. 476) described his *Elfvingia elmeri* from specimens collected by *A. D. E. Elmer* (*6961*) on dead wood, Mount Mariveles, Bataan Province, Luzon, Philippine Islands (Plate 3, figs. 5 and 6; Plate 5, fig. 4; Plate 7, fig. 7). The cotype of this in the Elmer herbarium is certainly not distinct from *Fomes pachyphloeus*, of which there are available for comparison two specimens from Indo-China and the Philippines determined by Patouillard. Bresadola(4) reported the two species as synonymous in 1912.

In the Bureau of Science there is a packet bearing the following data "*Pyropolyporus Merrillii* Murr. n. sp., on prostrate log, Island of Culion, *3575, E. D. Merrill,* Dec., 1902." This is indorsed "Cotype" but contains only a small specimen of typical *Fomes pachyphloeus* (Plate 3, figs. 7 and 8; Plate 5, fig. 6).

Murrill's description (18) of *Pyropolyporus merrillii* states that the type contains "no cystidia" and that it was collected in Culion "on decaying trees near the seashore, December, 1902, by *E. D. Merrill, No. 3575.*" On page 478, just preceding the original description of *P. merrillii,* Murrill cites *Pyropolyporus endotheius* also under No. *3575* but only with the data "Culion: *Merrill 3575.*"

Graff (10) reports under *Fomes merrillii* (Murr.) Sacc. and Trott. [Saccardo Syll. Fung. 21 (1912) 287] a No. *3575* "Culion: December, 1902, *Merrill 3575,* on decaying tree trunks near the seashore." He also cites (11) *Fomes endotheius* "Culion: December, 1902, *Merrill 3575.*" These citations appear to have been taken from the literature rather than the specimens, since there are not two collections at the Bureau of Science marked No. *3575* and he specifically states (10) in his introduction that "all the collections cited are preserved in the herbarium of the Bureau of Science Manila."

There is represented, however, in the Bureau of Science herbarium a No. *3570* with the following data "*Fomes fullageri* Berk. On decaying parts of living trees near the seashore. Culion, No. *3570, E. D. Merrill,* December, 1912. Det. Graff." while a portion of the same sporophore sent to the Baker herbarium, Los Baños, P. I., bears the legend "*Fomes merrillii.* On decaying portions of living trees. Island of Culion, No. *3570, E. D. Merrill,* Dec., 1902 Det. Bresadola." The date, 1912, on the Bureau of Science specimen is apparently a typographical error. No. *3575* was apparently not sent to Los Baños.

Since Murrill does not report *3570* it is to be presumed that this number applies to his type of *Pyropolyporus merrillii* which was inadvertently published as *3575.* This view is supported by the facts that the collector's data on No. *3570* agree rather closely with the data published under the original description and that the description fits the same specimen, rather than No. *3575.* It appears logical, therefore, to consider No. *3570* the type of *Fomes merrillii* (Murr.), while the No. *3575* referred by both Murrill and Lloyd to *Fomes endotheius* Berk.

should be considered, in the light of the specimen at the Bureau of Science, *Fomes pachyphloeus* Pat.

Bresadola mentions *Fomes merrillii* in one of his last critical papers(6) but only in comparison with *Fomes endotheius* Berk., from which he considers it distinct. He gives the size of pores and hyphæ in the type but says nothing about setæ, from which it is to be inferred that the specimen that he examined was the true type or cotype. His spore and hyphæ measurements differ slightly from similar measurements by us on No. *3570* but would readily fall within the normal range of variation.

Fomes pachyphloeus Pat. var. *inermis* Bresadola(5) was described from Polillo Island, Philippine Islands, and is represented in the Bureau of Science herbarium by a portion of a slice (*Bur. Sci. 10526*) (Plate 3, fig. 4; Plate 6, fig. 3). Bresadola states that it differs from the type in not having setæ. He considered it only an abnormality. An examination of the specimen shows that it possesses both types of setæ, although the smaller ones are few in number. It is, therefore, not worthy of varietal rank.

Fomes pachyphloeus Pat. var. *stipitatus* Bresadola(3) was created to cover a specimen from Java with a short lateral perpendicular stipe. Bresadola states that in other respects it agrees well with the type. It would, therefore, be a form only, rather than a variety.

MATERIAL OF FOMES PACHYPHLOEUS EXAMINED

Of the forty-four specimens critically studied all were from the Philippines except four; namely, one from southern Nigeria (Plate 5, fig. 5), distributed by the Kew Herbarium and probably determined by Miss E. M. Wakefield; one from Indo-China sent by Patouillard (Plate 3, fig. 9; Plate 5, fig. 3); and two from the Federated Malay States, forwarded by E. J. H. Corner from the Singapore herbarium.

They were all properly determined either as *Fomes pachyphloeus* or *Elfvingia elmeri* Murr., with the exception of one specimen (*36065*) called *Fomes robinsoniae* Murr. by Lloyd (Plate 2, figs. 3 and 4) and the specimen erroneously deposited in the Bureau of Science herbarium as the cotype of *Pyropolyporus merrillii* Murr. Three specimens listed(9) by Graff [*Clemens "s n," Forestry Bur. 6419* (possibly an error for *6491*), and *19222*] are missing from the Bureau of Science and the Baker herbaria. In all there are eight determinations or con-

firmations by Bresadola, two by Corner, six by Graff, four by Lloyd, two by Patouillard, and one by the Kew Herbarium, available for study. These specimens are all deposited in the Bureau of Science herbarium at Manila or in the Baker herbarium at Los Baños, sometimes in both. To Dr. G. O. Ocfemia, of the Department of Plant Pathology, College of Agriculture, Los Baños, we are deeply indebted for the privilege of examining the specimens of the latter herbarium.

DESCRIPTION OF SPOROPHORES OF FOMES PACHYPHLOEUS

SHAPE AND SIZE

Mature specimens of *Fomes pachyphloeus* vary from compressed hemispheric through ungulate to applanate, often attaining large size (Plates 1 to 4). Young specimens may appear as thick cushions or as compressed hemispheric pilei (Plate 2, figs. 5 and 9). One specimen (*50126*) collected on Mount Maquiling, Luzon, Philippine Islands, was 26 inches broad, 15 inches long, and 8.5 inches thick through two pilei which coalesced at the base (Plate 1, fig. 1). It weighed 14.3 kilograms (31.5 pounds) after removal from the log and drying for ten days during warm dry weather.

The sporophores are sometimes abundant on fallen trunks and on standing trees often appear high on the bole. When growing from the underside of logs not resting directly on the ground they may be attached at the center of the back or broadly effused in a resupinate condition behind (Plate 4, fig. 3). They are usually single, but occasionally two or three pilei may be loosely imbricated and coalescent behind (Plate 1, fig. 10). In rare instances a new pileus may originate from the lower surface of an old blackened one, much as they do in *Ganoderma lobatum* (Schw.) Atk. Blackened burl-like growths (Plate 4, fig. 4) may develop occasionally on the trunks of living trees, the one at hand being of light weight, corky (much like ground pressed cork), and brown, mottled with white, within (Plate 4, fig. 5), the entire outer surface being sterile, hoary brownish-black, roughly tubercular and abundantly fissured.

CONSISTENCY

The fungus is frequently of light weight when dry, particularly the young forms. When in a freshly growing condition the sporophores are usually saturated with water and heavy. The large specimen (*50126*) previously mentioned, after ten days of drying still weighed 31.5 pounds, but after another thirty-five

days in a hot laboratory during the dry season was reduced to 13.5 pounds, a loss of nearly 60 per cent of its original weight. This wet condition frequently leads to extensive cracking or fissuring (Plate 1, figs. 3 and 4; Plate 4, fig. 2), particularly of the pore surface, when the plant dries rapidly.

UPPER SURFACE

The upper surface is usually sulcate, often tuberculose, and not uncommonly radiately ridged, with the margin varying from subacute to bluntly rounded. Except in very young specimens, or at the young growing margins, the plant is provided with a distinct crust, varying from brownish black to black in section, and about 0.1 millimeter to 3 millimeters in thickness. This is much cracked in age, often becomes loosened, and has a tendency to flake away (Plate 3, figs. 5, 6, 10 and 11).

The younger specimens are, in general, of varying shades of brown, the youngest, or the growing margins of some of the older specimens, varying from near buckthorn brown (R) [quite similar to certain young specimens of *Polyporus gilvus* (Plate 3, fig. 12)] to clay color (R) or tawny olive (R). One collection of one to two seasons' growth is quite strikingly zoned, in the dried state being Saccardo's umber (R) near the margin, followed by narrow zones of dark grayish brown (R) and pallid mouse gray (R), with drab and hair brown (R) zones behind (Plate 2, fig. 6). When fresh the specimens were recorded as buffy brown (R) at the margin, grayish olive (R) behind, and narrowly zoned with blackish. In general, however, color zonation is not a conspicuous feature.

Other specimens vary from cinnamon brown (R) to Prout's brown (R). Many become dark, particularly in age, then varying from Chaetura drab (R) to blackish slate (R).

LOWER SURFACE

The lower surface may be nearly plane to convex, occasionally concave, and is sometimes perforated by numerous insect holes about 1 millimeter in diameter and extending in for 1 to 2 centimeters (Plate 3, fig. 2). It also frequently cracks in drying (Plate 1, figs. 4 and 7), the crevices thus opened up sometimes being 1 to 1.5 centimeters wide. This cracking, however, is largely dependent upon the moisture content of the specimen and the rate at which it dries; some sporophores show no indication of it.

Field notes on four collections indicate that the colors of newly collected specimens vary from olive green [Saccardo's umber tinged with brownish olive (R) when dry], raw umber (R) [sepia (R) when dry], light brownish olive (R), sepia (R) on bruising [near olive brown (R) on drying, bister (R) where bruised], clay color (R) to near snuff brown (R) [near argus brown (R) when dry]. It will thus be noted that olivaceous shades predominate in the fresh material.

In the series of forty-four collections examined, all of which were dry and some of them sublimated, the colors fall into four principal groups: Yellowish browns, drab browns, olive browns, and deep browns. The first is rare, the others well represented. Of the Ridgway colors the following were noted: slightly darker than isabella color (one specimen), near cinnamon drab (Nigerian specimen), between benzo brown and hair brown, near fuscous, near fuscous black, snuff brown, Saccardo's umber, near argus brown, near cinnamon brown (specimen from Federated Malay States), near mummy brown, sepia, and near olive brown.

CONTEXT

The context (Plates 2, 3, and 4; Plate 7, figs. 6 and 7) varies from thin (sometimes almost lacking with the pores seated very close to the hard crust) to 3.5 centimeters in the specimens cut, although in very large specimens it is probably thicker. It is often obscurely zoned and is composed of radiating fibers, the consistency varying from soft corky to woody.

There is comparatively little variation in the color, young or immature specimens usually being tawny olive (R) with a silky sheen. In the mature Nigerian specimen it is near Brussels brown (R). In Philippine specimens it darkens with the age of the sporophore, the Ridgway colors noted in the older plants being near snuff brown, tawny olive, and antique brown with fine longitudinal streaks of white, or antique brown mottled with white and fuscous black.

PORES

The pores (Plates 2, 3, and 4; Plate 7, figs. 6 and 7; Plate 10, figs. 1 to 4) are small and only obscurely set off from the context, the color in longisection ranging around cinnamon brown (R), buckthorn brown (R), and Dresden brown (R). They are usually indistinctly stratified and more commonly with only a few layers of seasonal growth. One ungulate specimen, how-

ever, had thirteen layers (Plate 4, fig. 2). The seasonal growth rarely exceeds 3 centimeters and is very often only a few millimeters. Usually there is no sterile tissue between the layers, but Patouillard (24) reports such sterile layers of tramal tissue in a specimen from Annam, and they are shown to a slight degree in one specimen from the Federated Malay States. Occasionally the layers have a tendency to separate in dry material, and sometimes there is an infiltration of the hard blackish crust substance between them. This same infiltration may also occur vertically through the older pore layers, in which case they become very hard. Usually they are soft corky to firm corky, although occasionally woody. In most cases they can be broken out with the thumb nail.

The orifices, at the surface, vary from subangular to angular, rarely circular (Plate 10, figs. 1 to 3), but in cross section they are for the most part circular to subcircular. They are quite variable in size, the averages of five measurements on each of nine dried specimens from eight collections ranging from 6.4 to 10 per millimeter (6.4, 6.4, 7.4, 7.6, 8.6, 9.0, 9.5, 9.5, 10.0). The dissepiments are usually thin. They may be entire or may show all stages between slight and marked erosion. At times they are entirely occluded at the surface and in one instance the surface was distinctly raduloid (Plate 10, fig. 4).

TECHNIC

Microscopic measurements of hyphæ and spores were made with a 1/12a fluorite oil-immersion objective and 10x Huyghenian ocular, using a Leitz microscope, with a tube length of 160 millimeters, while colors of these elements were observed with the No. 6 (4-millimeter) objective and the same ocular. Photomicrographs of spores were made from crushed mounts of the pores in 7 per cent potassium hydroxide, using the 1/12a oil immersion and 8x ocular. Other elements were photographed with various combinations of dry objectives and the higher oculars, as indicated by the magnifications given in the plate descriptions. Sections were all free-hand, of material soaked in 7 per cent potassium hydroxide.

Approximately 310 pore hyphæ, 280 context hyphæ, 270 pore setæ, 260 context setæ, and 100 spores, from 22 collections, were measured.

Pore surfaces of three representative specimens were photographed through a 35-millimeter Zeiss Planar lens fitted to a Leitz microscope with 6x ocular and 160-millimeter tube length,

using the small Bausch and Lomb fixed-bellows camera. The number of pores per millimeter was determined by use of a millimeter celluloid scale and a hand magnifier.

Colors were compared with those in Ridgway's Color Standards and Color Nomenclature and all direct comparisons are indicated by (R) following the color name.

MICROSCOPIC STRUCTURE

All parts of the sporophore contain abundant, subacute to rather blunt, yellowish brown to dark reddish brown, elongate, thick-walled, seta-like bodies (Plates 5 and 6; Plate 7, figs. 1, 3, 4, and 5) which follow the course of the regular hyphæ and sometimes project through the young crust (Plate 7, fig. 2; Plate 9, fig. 6). Patouillard(23) reported a young Tonkin specimen as having the charateristic crust only over the posterior portion of the sporophore with the anterior portion provided with a compact velvety covering consisting of erect cystidiform bristles analogous to those in the trama and stated that, after collecting, the same organs were produced on the inner surface of the bark, the growth resembling the hymenial surface of a Hymenochæte. In another paper(22) he states with reference to a specimen from Cambodia that in all its parts, tubes, trama, and even the crust one finds the long cystidiform filaments characteristic of the species.

In the pore walls these seta-like organs run parallel with the thinner walled yellowish-brown dissepiment hyphæ which are compactly arranged longitudinally, although occasionally somewhat oblique. Ordinarily the tips do not project through the hymenium, although there is a slight tendency to do so at the extremity of the dissepiments (Plate 6, figs. 7, 8, and 9). In the context they follow the course of the obliquely arranged hyphæ composing it (Plate 7, figs. 1 and 5).

These setuliform bodies vary greatly in length and apparently arise from the modification of the ends of the regular hyphæ. Sometimes they closely resemble normal setæ, there being an abrupt change from hypha to seta (Plate 9, fig. 7), but usually there is a very gradual transition in color, size, and shape. They are usually quite straight but curved or somewhat flexuous ones are not uncommon. Two hundred thirty measurements made on seventeen collections (ten for each specimen) gave limits of 46.9 μ to 264.2 μ in length and 8.7 to 20.9 μ in width, with an average of 104.64 μ for the length and 12.45 μ for the width.

In addition, small, usually ventricose, setæ (Plates 5 and 6; Plate 7, figs. 3 and 4; Plate 9, fig. 8) of the same general color, although frequently lighter, arise in greater or less abundance from the subhymenial hyphæ. These are also thick walled, straight, or sometimes curved, and are acute at the tip. They are quite loosely seated and tend to break out in sectioning. Two hundred thirty measurements from the specimens noted in the preceding paragraph yielded variations in length from 12.2 to 29.5 μ and in width from 3.5 to 8.7 μ with averages of 18.06 and 5.88 μ, respectively.

The dissepiment hyphæ (Plates 5 and 6; Plate 7, figs. 3 and 4) are rather compact, run generally parallel to the walls of the pores, and are yellowish brown [old gold (R) to buckthorn brown (R) under the high power of the microscope], with moderately thin to rather thick walls. They average 3.12 μ for two hundred thirty measurements, varying between 1.7 and 5.2 μ.

The context hyphæ (Plate 7, figs. 1 and 5) are of the same color, appear to be somewhat thinner walled, more loosely arranged, and with a greater tendency to collapse. They show the same variation in size as the dissepiment hyphæ, with nearly the same average diameter (3.18 μ for two hundred twenty measurements). They may run parallel to the crust or obliquely to it. The crust (Plate 7, figs. 1 and 2) is composed of compact thick-walled hyphæ, usually with a general vertical arrangement. They are so compact, however, that they almost lose their identity.

In the original description Patouillard (20) records the spores as subglobose, colorless under the microscope, smooth, 5 to 6 μ. Later (24) he gives them as subglobose, straw colored, 4 μ, for a specimen from Annam. Bresadola (2) records them as globose, stramineus, 3 to 5 μ, in the specimen from Kamerun cited by Patouillard in the original description, and for Philippine material (4) as globose, 5 to 6 by 4.5 to 6 μ. Lloyd (16) gives them as rare, globose, 8 μ, pale colored. For *Elfvingia elmeri* Murrill (18, p. 476) reports them as ferruginous, globose, smooth, 5 to 6 μ.

The writers have examined all the specimens available and have found only three collections with spores. In one they were abundant, in the others scarce. They vary from nearly colorless, but with a slight tinge of yellow, to near snuff brown (R) (in water or 7 per cent potassium hydroxide) under the high power of the microscope. As a rule they are globose to sub-

globose, but some tend toward subelliptic or ovate (Plate 10, figs. 5 and 6). The walls are smooth and moderately thick. Many are uniguttulate. The three collections were examined in crushed mount. In one the spores were 4.2 to 4.9 by 4.5 to 4.9 μ, with an average (10 measurements) of 4.5 by 4.6 μ. In another they were 4.2 to 5.4 by 4.2 to 5.6 μ with an average (30 measurements) of 4.7 by 4.9 μ. In the third (*Bur. Sci. 50280*) they were 2.8 to 3.5 by 3.5 to 4.2 μ, averaging (40 measurements) 3.3 by 4.0 μ. This last specimen is a rather thin shelving form, effused behind, with aberrant upper surface characters, approaching light seal brown (R) and narrowly sulcate. The spores (Plate 10, fig. 5) are copious and dark, as compared with the other two specimens. The under surface and the structure are sufficiently typical for the species, however, although the setiform bodies of the dissepiments run rather erratically and often project into the pores, and the pore setæ are less ventricose and taper rather gradually to an acute point.

SPECIMENS EXAMINED

AFRICA

Southern Nigeria, Agolo, Obu, *N. W. Thomas* (*Herb. Hort. Bot. Reg. Kew*) (B).[2]

FEDERATED MALAY STATES

Johore, Bagan Limau, Sungu Sedili, on living tree, *E. J. H. Corner 24491* (S; B. S.), Pahang, Tembeling, on dead *Ficus, E. J. H. Corner 24197* (S; B. S.).

INDO CHINA

Cambodia, Reserve forestière de Compong Chhnang, on rotten trunk, *Herb. Patouillard 273* (B. S.).

PHILIPPINE ISLANDS

BASILAN, Isabela, on living *Hopea* sp., *H. S. Yates 36065* (B. S.).

CULION, on prostrate log, *E. D. Merrill 3575* (Specimen marked in error as cotype of *Pyropolyporus merrillii* Murr.) (B. S.).

[2] Abbreviations are given in parenthesis, following the number, to indicate the herbaria in which the specimens cited are deposited. Thus, (B) refers to the Baker herbarium, at Los Baños, Philippine Islands; (B. S.) to the Bureau of Science, Manila; and (S) to the Singapore herbarium.

LUZON, locality unknown, *50153* (B. S.).

Bataan Province, *H. M. Curran, Forestry Bureau 19240* (B. S.), Lamao, on dead *Albizzia procera* (Roxb.) Benth., *H. M. Curran 19253* (B. S.), *15587* (B. S.; B), Morong, on stump of *Parkia javanica* (Lam.) Merr., *H. M. Curran, Forestry Bureau 6491* (B. but not B. S.), Mount Mariveles, *A. D. E. Elmer 6961* (cotype of *Elfvingia elmeri* Murr., in *Elmer herbarium*), on fallen *Pentacme contorta* (Vid.) Merr. and Rolfe, *C. J. Humphrey 50147* (B. S.), on nearly dead *Pentacme contorta, C. J. Humphrey 50148* (B. S.), on living *Hopea acuminata* Merr., *C. J. Humphrey and L. Reyes 50144* (B. S.), on fallen *Shorea guiso* (Blco.) Blm., *C. J. Humphrey and L. Reyes 50279* (B. S.).

Bulacan Province, Sibul Springs, *C. J. Humphrey 50149* (B. S.).

Laguna Province, Los Baños, *A. D. E. Elmer, Philippine Islands Plants 18328* (B. S.), Mount Maquiling, *C. F. Baker 3962* (B), on large nearly dead *Parashorea malaanonan* (Blco.) Merr., *C. J. Humphrey 50137* (B. S.), on fallen trunk, *C. J. Humphrey 50126* (B. S.), *50128* (B. S.), *50129* (B. S.), on stump of *Pentacme contorta* (Vid.) Merr. and Rolfe, *C. J. Humphrey 50155* (B. S.), on nearly dead *Pentacme contorta* (Vid.) Merr. and Rolfe, *C. J. Humphrey 50142* (B. S.), on fallen log, *P. W. Graff 21032* (B. S.), on fallen trunk *Parashorea malaanonan* (Blco.) Merr., *C. J. Humphrey 50138* (B. S.), on fallen trunk, Pangil, *C. J. Humphrey 50130* (B. S.).

Pampanga Province, Mount Arayat, *M. S. Clemens 1612* (B. S.).

Tayabas Province, Mount Cadig, *H. S. Yates 25728* (B. S.; B.).

Zambales Province, Olongapo, *M. S. Clemens 4551* (B. S.).

MINDANAO, Cotabato Province, Sarunayan, on small dead standing trunk, *C. J. Humphrey 50143* (B. S.).

Lanao Province, Lake Lanao, Camp Keithley, *M. S. Clemens "a"* (B).

Zamboanga Province, on living *Pentacme mindanensis* Foxw., *C. J. Humphrey 50145* (B. S.), on living *Hopea philippinensis* Dyer, *C. J. Humphrey 50154* (B. S.), on dead fallen mangrove, *Rhizophora candelaria* DC., Kabasalan swamp, *R. F. Wendover 50140* (B. S.), on dead fallen *Rhizophora mucronata* Lam., *R. F. Wendover 50141* (B. S.), on hollow nearly dead *Shorea negrosensis* Foxw., *C. J. Humphrey 50146* (B. S.), on fallen trunk, *C. J. Humphrey 50151* (B. S.), *50152* (B. S.), *50280* (B. S.).

PALAWAN, Mount Kabangaan, *Buenaventura Reyes 50156* (B. S.).

POLILLO, *R. C. McGregor 10526* (cotype of *Fomes pachyphloeus* Pat. var. *inermis* Bres.) (B. S.), *10554* (B. S.)

FOMES MAGNOSPORUS Lloyd.

This species was described(15) in 1914 from a specimen collected by H. A. Lee at Lamao, Bataan Province, Luzon, Philippine Islands. The single specimen (Plate 4, figs. 6 to 8) was found on *Canarium villosum* (Bl.) F. Vill., but whether on a fallen log or on a living tree is not stated. As it has never been found since, the only material at the Bureau of Science consists of approximately one-half a subapplanate sporophore which originally was about 20 centimeters wide. It is 12 centimeters long and 7 centimeters thick at the base, rather irregular in shape, and imperfectly developed.

The upper surface is very uneven, uniformly near to bister (R), and gives the impression that new abortive coalescent pilei have developed upwards from the original surface. It is somewhat rough to the touch, but under a 14x hand lens appears finely pubescent (Plate 8, figs. 4 and 6); scrapings yield abundant, somewhat flexuous, pale hyphæ (Plate 9, fig. 4) but no setæ.

The lower surface is ascending, quite irregular, with a few abortive pilei forming here and there. The older areas are near Natal brown (R), while the younger growth is slightly darker than chamois (R).

The context is firm corky, becoming woody in places, and varies from near raw sienna (R), through Sudan brown (R), to Brussels brown (R). Streaks of the lighter color occur more or less parallel to the lower surface, and these correspond to abortive pore areas. The upper portion is the darkest and approaches Brussels brown. Rather obscure concentric zonation occurs throughout, consisting for the most part of mottled bands as shown in Plate 8, fig. 1.

The pores (Plate 8, fig. 1) are quite abortive, occurring in two interrupted zones separated by much sterile tissue. At the surface they are at best only shallow pits and are usually entirely lacking. At the few places they occur in the section of the sporophore they are approximately three to the millimeter and frequently stuffed, the maximum length at one spot being about 1 centimeter.

MICROSCOPIC STRUCTURE

In the pore walls and context occur a few scattered seta-like bodies (Plate 8, figs. 2, 3, 5, and 7; Plate 9, figs. 2 and 5) of the same general form as in *Fomes pachyphloeus*, but often somewhat lighter in color. These range from 5.2 to 8.6 μ wide to 26 to 60 μ long, with an average of 6.5 by 38 μ for five measurements. None were observed in the crust. No small setæ, such as are characteristic of *F. pachyphloeus*, occur in the hymenium, but occasionally the long dissepiment setæ may project slightly into the pores.

The context (Plate 9, figs. 1, 3, and 5) is composed of compactly arranged, rather thick-walled to very thick-walled hyphæ generally running horizontally, with an occasional darker seta-like hypha intermixed. These context hyphæ are quite variable in size and wall thickness, the lumen being almost closed in many of them. A tangential section shows them to be fused to a large extent, so that the preparation appears as a porous mass (Plate 9, fig. 3). While the general tendency is parallel there are some areas in which they are considerably intertwined. The color is golden to yellowish brown in thin sections. The size varies from 2.5 to 7.1 μ, with an average (50 measurements) of 4.1 μ.

The dissepiment hyphæ (Plate 8, figs. 2, 3, 5, and 7; Plate 9, fig. 2) are essentially the same color as those of the context, compact, usually rather thick walled, and with a general parallel arrangement. In size they vary from 2.1 to 5.6 μ, with an average (40 measurements) of 3.6 μ. Scattered in the tissue are a few of the much darker seta-like hyphæ, which offer considerable contrast in size and color.

The spores (Plate 10, fig. 7) are copious in crushed mount, but have not been observed attached to basidia, since the hymenium is badly disorganized. They lie along the pore walls in considerable numbers, however. In the absence of any foreign mycelium in the sections it would thus appear that they pertain to the species. They are globose, or nearly so, often granular within, distinctly apiculate, thin walled to medium thick walled, the thin-walled ones sometimes collapsing. The color is rather unusual, varying from very dilute vinaceous lavender (R) to deep purplish vinaceous (R) for the apparently more mature ones, which are fewer in number than the paler ones. When measured at right angles to an axis through the apiculus they give an average of 7.5 μ (50 measurements), varying between

6.8 and 8.5 μ. Lloyd gives them 11 to 12 μ, but we have found none that large.

There is a somewhat general resemblance between *Fomes magnosporus* and *Fomes pachyphloeus* but the microscopic features will readily separate them. The points of particular contrast are as follows:

Pore setæ present in *pachyphloeus,* not in *magnosporus.*

Context setæ quite similar in appearance in both but usually abundant in *pachyphloeus,* few and scattered in *magnosporus* and lacking in the crust of that species.

Spores usually globose, but tending to subelliptic or ovate, slightly tinged with yellowish to near snuff brown, not exceeding 6 μ in diameter in *pachyphloeus;* globose, very dilute vinaceous lavender to deep purplish vinaceous, varying from 6.8 to 8.5 μ in diameter in *magnosporus.*

SUMMARY

A detailed microscopic examination of forty-four specimens of *Fomes pachyphloeus* Pat. coming from the Philippines, Africa, Federated Malay States, and Indo-China was made. All the specimens were found to agree closely in micro-characters, although the consistency and spores offered considerable variation. The distinguishing characters consist in the presence of small brown setæ in the pores, and large brown setæ or seta-like hyphæ throughout the tissues and extending through the crust.

The type collection of *Fomes magnosporus* Lloyd was examined in comparison with *pachyphloeus* and found to differ in microscopic structure sufficiently to maintain it as a distinct species, the principal differences being the lack of pore setæ, the comparatively few large setæ or seta-like hyphæ in the context and pore walls but not in the crust, and the size and color of the spores.

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ILLUSTRATIONS

PLATE 1

FOMES PACHYPHLOEUS PAT.

FIG. 1. Upper surface of a large sporophore, 27.5 inches wide, *50126* (B. S.), Luzon, P. I. The young lady is the junior author; × 0.06.
2. Upper surface of *50148* (B. S.), Luzon, P. I.; × 0.20.
3. Front-side view of *50138* (B. S.), Luzon, P. I., showing fissuring after drying; × 0.44.
4. Front view of another specimen of *50138*, showing cracking of the lower surface; × 0.32.
5. Upper surface of a small specimen of *50138;* × 0.36.
6. Upper surface of a strongly sulcate specimen of *50138;* × 0.32.
7. Lower surface of an old blackened sporophore of *50138*, with excessive cracking; × 0.32.
8. A very young nodular sporophore from *Pentacme contorta, 50148* (B. S.); × 0.35.
9. Sporophore on *Rhizophora candelaria* DC., *50140* (B. S.), Mindanao, P. I.; × 0.10.
10. Front-top view of an irregular sporophore, *50146* (B. S.), Mindanao, P. I.; × 0.39.

PLATE 2

FOMES PACHYPHLOEUS PAT.

FIG. 1. Upper surface of a rather hard, heavy, narrowly sulcate sporophore, *50145* (B. S.), Mindanao, P. I.; × 0.30.
2. Under surface of *50145* shown in fig. 1, with only slight cracking; × 0.28.
3. Upper surface of a sporophore, *36065* (B. S.), Basilan, P. I., determined by Lloyd as *Fomes robinsoniæ;* × 0.35.
4. Section of *36065* shown in fig. 3; × 0.39.
5. A young compressed-hemispheric sporophore, with section, *Clemens 1612*, Luzon, P. I.; × 0.42.
6. Upper surface of a young, zonate, corky, light-weight sporophore, *50149*, (B. S.), Luzon, P. I.; × 0.29.
7. Lower surface of *50149* shown in fig. 6; × 0.29.
8. Section of *10554* (B. S.), Polillo, P. I., determined by Bresadola. Note the fibrous character of the context and the fine pores; × 0.29.
9. Abortive fructification of *21032* (B. S.), Luzon, P. I., determined by Bresadola; × 0.39.
10. Section of *50149* shown in figs. 6 and 7; × 0.42.

PLATE 3

FOMES PACHYPHLOEUS PAT.

FIG. 1. Front view of an ungulate-hemispheric sporophore, *50143* (B. S), Mindanao, P. I.; × 0.28.

2. Lower blackened surface of *50143* shown in fig. 1. Note the numerous insect holes; × 0.29.
3. Section of a more typical sporophore of *50143;* × 0.30.
4. Section of *Fomes pachyphloeus* Pat. var. *inermis* Bres., *10526* (B. S.) (cotype), Polillo, P. I.; × 0.29.
5. Section of *Elfvingia elmeri* Murr., *Elmer's Philippine Islands Plants 6961* (cotype), Luzon, P. I.; × 0.27.
6. Upper surface *6961* shown in fig. 5; × 0.27.
7. Side view from above of the specimen marked as the cotype of *Pyropolyporus merrillii* Murr., *3575* (B. S.), Culion, P. I. This is typical *F. pachyphloeus* and was apparently mislabeled. It has no affinities with *P. merrillii;* × 0.36.
8. Section of *3575* shown in fig. 7; × 0.36.
9. Young atypical specimen in the Bureau of Science from Patouillard (*273*), Cambodia, Indo-China; × 0.29.
10. Section of *19240* (B. S.), Luzon, P. I. Determined by Bresadola; × 0.27.
11. Upper surface of *19240* shown in fig. 10. Note the flaking crust, which is not an unusual feature of the species; × 0.25.
12. Upper surface of a very young atypical specimen with almost the same coloration as young *Polyporus gilvus* Schw., 50147 (B. S.), Luzon, P. I.; × 0.39.
13. View from behind of *50156* (B. S.), Palawan, P. I., showing a specimen with a strongly concave upper surface; × 0.17.
14. Upper surface of half of an old, hard, blackened sporophore, *50142* (B. S.), Luzon, P. I.; × 0.37.
15. Side view of a small ungulate form of *50142;* × 0.36.
16. Upper surface of another specimen of *50142;* × 0.37.

PLATE 4

FOMES PACHYPHLOEUS PAT. AND FOMES MAGNOSPORUS LLOYD

FIG. 1. Side-front view of *F. pachyphloeus*, 50137 (B. S.), Luzon, P. I. This is of rather unusual shape; × 0.30.

2. Section of *50137* shown in fig. 1. Note the cracks extending through the pore layers; × 0.31.
3. Side view of an irregular sporophore of *F. pachyphloeus* broadly attached behind, *50128* (B. S.), Luzon, P. I.; × 0.31.
4. Burl-like, abortive, sterile growth of *F. pachyphloeus* on *Rhizophora mucronata* Lam., 50141 (B. S.), Mindanao, P. I.; × 0.27.
5. Section of *50141* shown in fig. 4; × 0.37.
6. Side view of *Fomes magnosporus* Lloyd, *48* (B. S.) (cotype), Luzon, P. I. Note the young nodular pilei developing from the convex lower surface; × 0.25.
7. Front-upper surface view of the specimen shown in fig. 6; × 0.30.
8. Section of the specimen shown in figs. 6 and 7; × 0.39.

PLATE 5

FOMES PACHYPHLOEUS PAT.

FIG. 1. Longisection of the pores of *Clemens "a"*, Mindanao, showing setæ in the walls. Determined by Bresadola; × 85.

2. Cross section of the pores of *Clemens "a"* showing setæ of varying size and wall-thickness; × 288.
3. Longisection of the pores of *Patouillard, 273*, Indo-China, with a number of the small hymenial setæ; × 85.
4. Longisection of the pores of *Elfvingia elmeri* Murr., *Elmer 6961* (cotype), Luzon, P. I.; × 85.
5. Longisection of the pores of the Nigerian specimen from Kew in the Baker herbarium; × 85.
6. Longisection of the pores of *3575* (B. S.), Culion, P. I. This specimen is marked in error as the cotype of *Pyropolyporus merrillii* Murr.; × 85.

PLATE 6

FOMES PACHYPHLOEUS PAT.

FIG. 1. Longisection of the pores of *50149* (B. S.), Luzon, P. I.; × 64.

2. Cross section of the pores of *50149*, showing abundant large setæ in the walls and a considerable number of small hymenial setæ; × 64.
3. Longisection of the pores of *10526* (B. S.), Polillo, P. I. Cotype of variety *inermis* Bres. Note the few scattered hymenial setæ characteristic of the species; × 64.
4. Longisection of the pores of *50280* (B. S.), Mindanao, P. I.; × 64.
5. Longisection of the pores of *24197* (S; B. S.), Federated Malay States; × 64.
6. Cross section of the pores of *24197* (S; B. S.); × 64.
7. Longisection of pores at the tips, *50146* (B. S.), Mindanao, P. I. Note the few paler, slightly projecting, setæ at some of the tips; × 64.
8. Longisection of pores at the tips, *50149* (B. S.), Luzon, P. I.; × 64.
9. Oblique longitudinal section of pores at the tips of *50156* (B. S.), Palawan, P. I.; × 64.
10. Cross section of the pores of *10554* (B. S.), Polillo, P. I. Determined by Bresadola; × 216.
11. Cross section of the pores of *50151* (B. S.), Mindanao, P. I.; × 180.

PLATE 7

FOMES PACHYPHLOEUS PAT.

FIG. 1. Radial section of the context just beneath the crust of *50149* (B. S.), Luzon, P. I., showing numerous dark seta-like hyphæ; × 42.

2. Radial section of the crust of *50149* with a single seta projecting through the surface; × 97.

FIG. 3. Longisection of a single pore wall of *Clemens 4551* (B. S.), Luzon, P. I., showing the two types of setæ highly magnified.

4. Cross section of the pores of *Clemens 4551* at the same magnification as in fig. 3.
5. Radial section of the context of *50149*, showing abundant dark seta-like hyphæ; × 97.
6. Radial section of the context and pores of *50149;* × 4.
7. Radial section of the context and pores of *Elfvingia elmeri* Murr., *6961* (Cotype in Elmer herbarium); × 4.

PLATE 8

FOMES MAGNOSPORUS LLOYD, NO. 48, TYPE COLLECTION

FIG. 1. Longisection through the context and a small pore area near the margin. The mottling of the context is well shown above and below. There is a strong tendency to produce the *Myriodoporus* type of pores in certain areas, as shown here, but these are always stuffed; × 4.6.

2. Cross section of the pores. The seta-like hyphæ are not very distinct under low magnification. A few of them have been circled; × 33.
3. Cross section of same more highly magnified to bring out the relative size of the ordinary hyphæ and seta-like ones; × 248.
4. Section of the crust showing the loose, vertical arrangement of the hyphæ; × 33.
5. Longisection of the pores showing the few scattered seta-like hyphæ at low magnification; × 33.
6. Radial section of the crust at somewhat higher magnification than shown in fig. 4; × 73.
7. Longisection of the pores at a higher magnification than in fig. 5, showing two of the seta-like hyphaæ; × 73.

PLATE 9

FOMES MAGNOSPORUS LLOYD AND FOMES PACHYPHLOEUS PAT.

FIG. 1. Radial section of *Fomes magnosporus, 48,* through a compact portion of the context; × 288.

2. Longitudinal section of the pores of *Fomes magnosporus, 48,* at a much higher magnification than shown in Plate 8, fig. 7; × 288.
3. Tangential section of the same portion of the context as shown in fig. 1; × 288.
4. Hyphæ of *Fomes magnosporus, 48,* from scrapings from the upper surface. Such scrape mounts have never shown the presence of setæ, as they do in *Fomes pachyphloeus;* × 288.
5. Radial section of the context of *Fomes magnosporus, 48,* showing a single seta-like structure. These are rare in the context of this species; × 288.
6. Hyphæ and a typical seta from scrapings from the upper surface of *Fomes pachyphloeus, 50149* (B. S.), Luzon, P. I. Compare with *Fomes magnosporus*, fig. 4, which shows much larger hyphæ and no setæ; × 288.

FIG. 7. A context seta of *Fomes pachyphloeus, 10554* (B. S.), Pollilo, P. I., photographed from a crushed mount of the pores; × 288.

8. Hymenial setæ from crushed mounts of the pores of *Fomes pachyphloeus,* showing wide variation in size and shape, *a,* from *Elmer 13328; b,* from *Bur. Sci. 50145; c,* from *Bur. Sci. 50149;* × 288.

PLATE 10

FOMES MAGNOSPORUS LLOYD AND FOMES PACHYPHLOEUS PAT.

FIG. 1. Pore surface of *Fomes pachyphloeus, 50145* (B. S.), Mindanao, P. I.; × 20.

2. Pore surface of *Fomes pachyphloeus, 50149* (B. S.), Luzon, P. I.; × 20.

3. Pore surface of another specimen of *50149,* with thin-walled, eroded dissepiments; × 20.

4. Pore surface of *Fomes pachyphloeus, 15587* (B. S.), Luzon, P. I. Determined as *Elfvingia elmeri* Murr. by Bresadola. The pores are occluded, the pore surface being raduloid; × 20.

5. Spores from a crushed pore mount of *Fomes pachyphloeus, 50280* (B. S.), Mindanao, P. I. They are comparatively small and dark for the species; × 785.

6. Spores from a crushed pore mount of *Fomes pachyphloeus, 50149.* They range somewhat larger than the preceding and are paler in color; × 785.

7. Spores from a crushed mount of the type of *Fomes magnosporus* Lloyd, *48* (B. S.); × 785.

INDEX TO SPECIMENS ILLUSTRATED

FOMES PACHYPHLOEUS PAT.

— Baker herbarium, Nigeria: Plate 5, fig. 5.
"a", Clemens, Philippines: Plate 5, figs. 1 and 2.
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FOMES MAGNOSPORUS LLOYD

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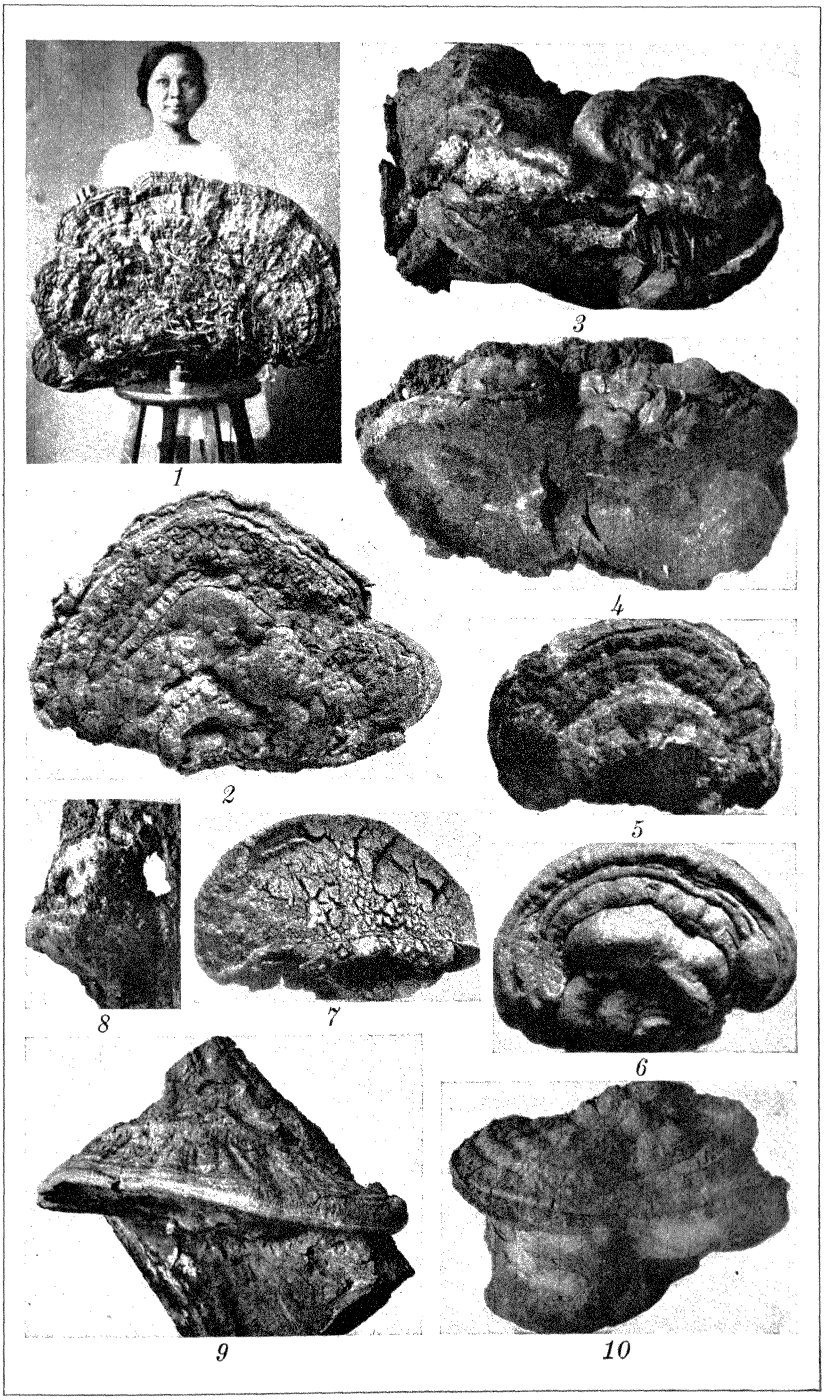

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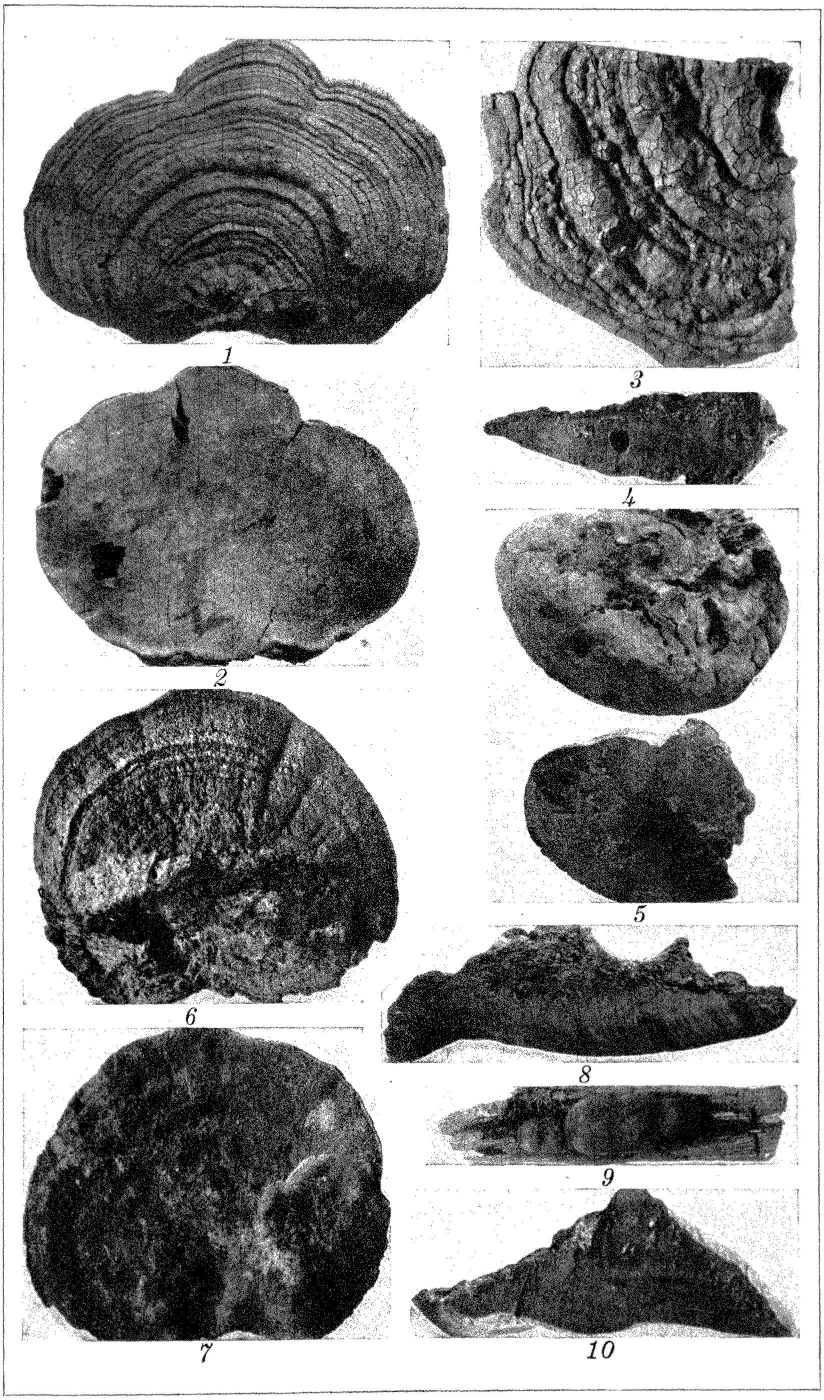

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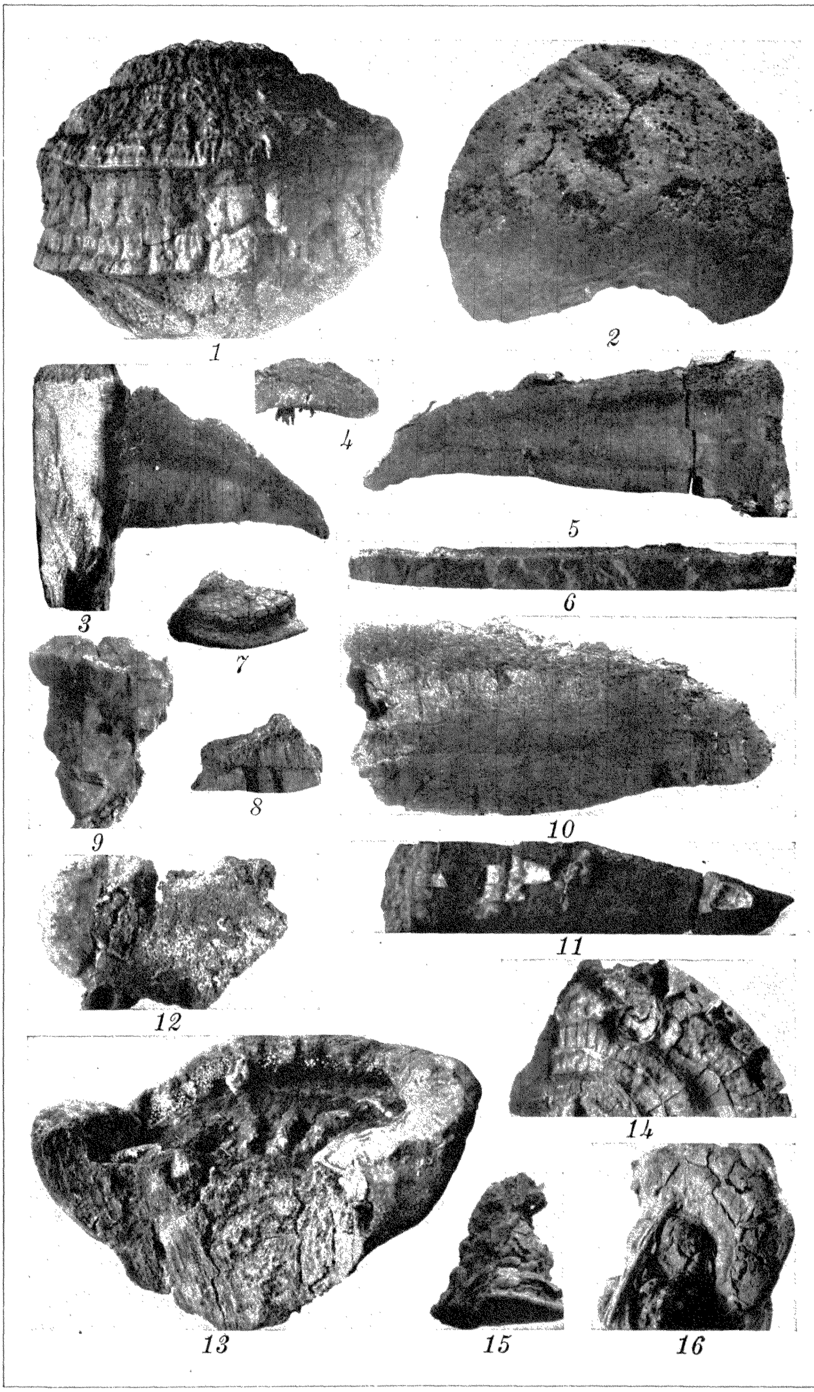

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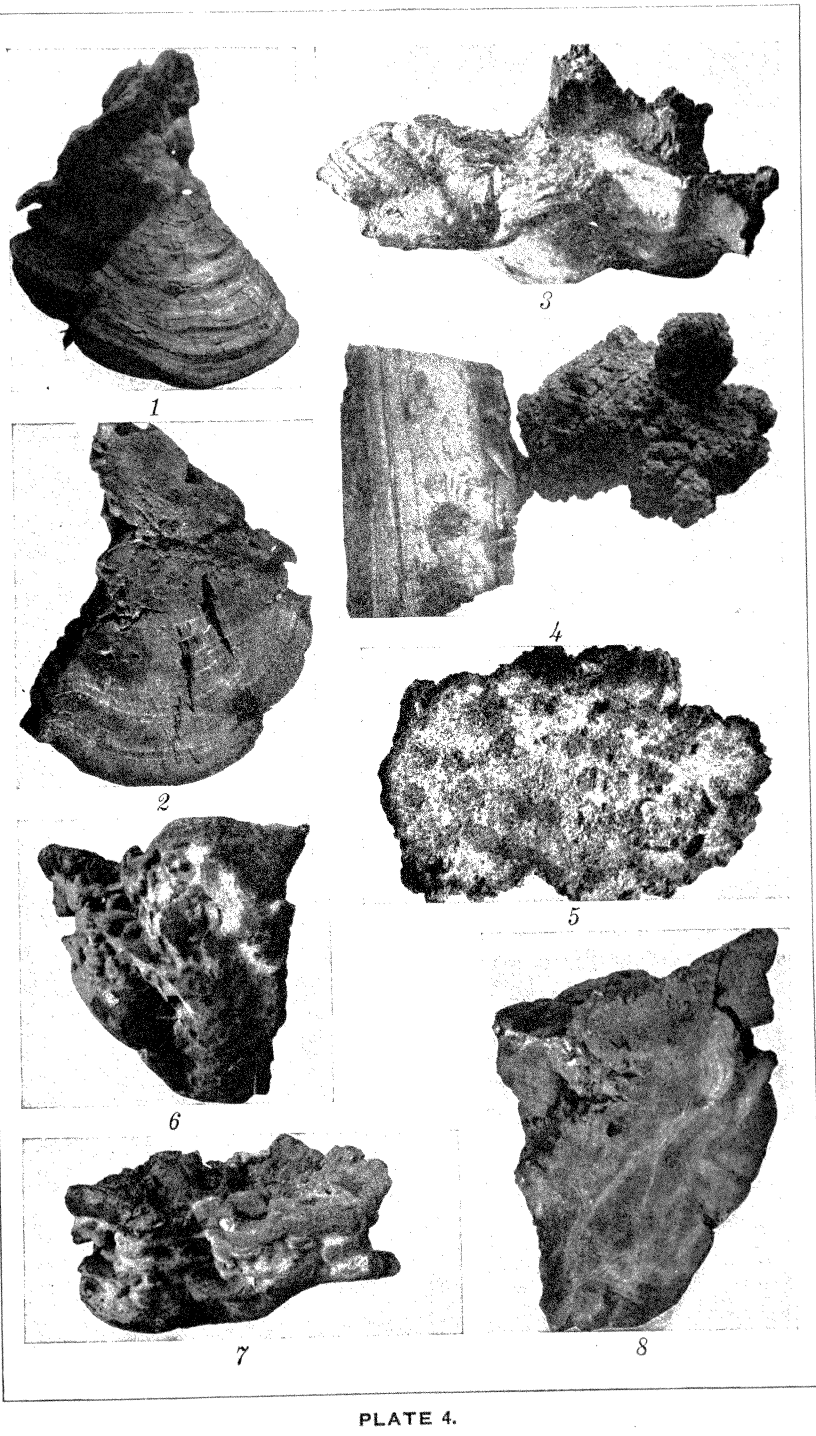

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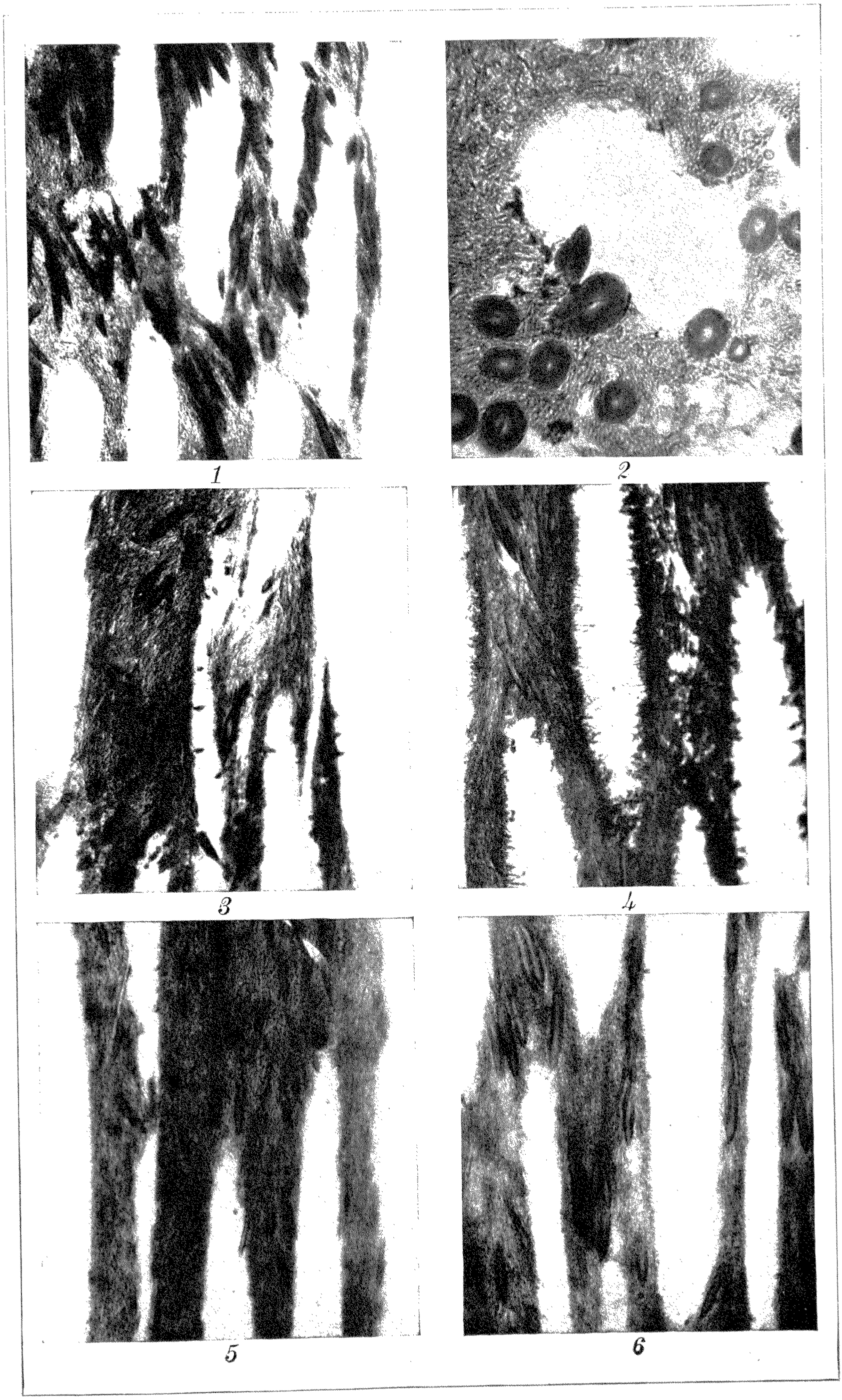

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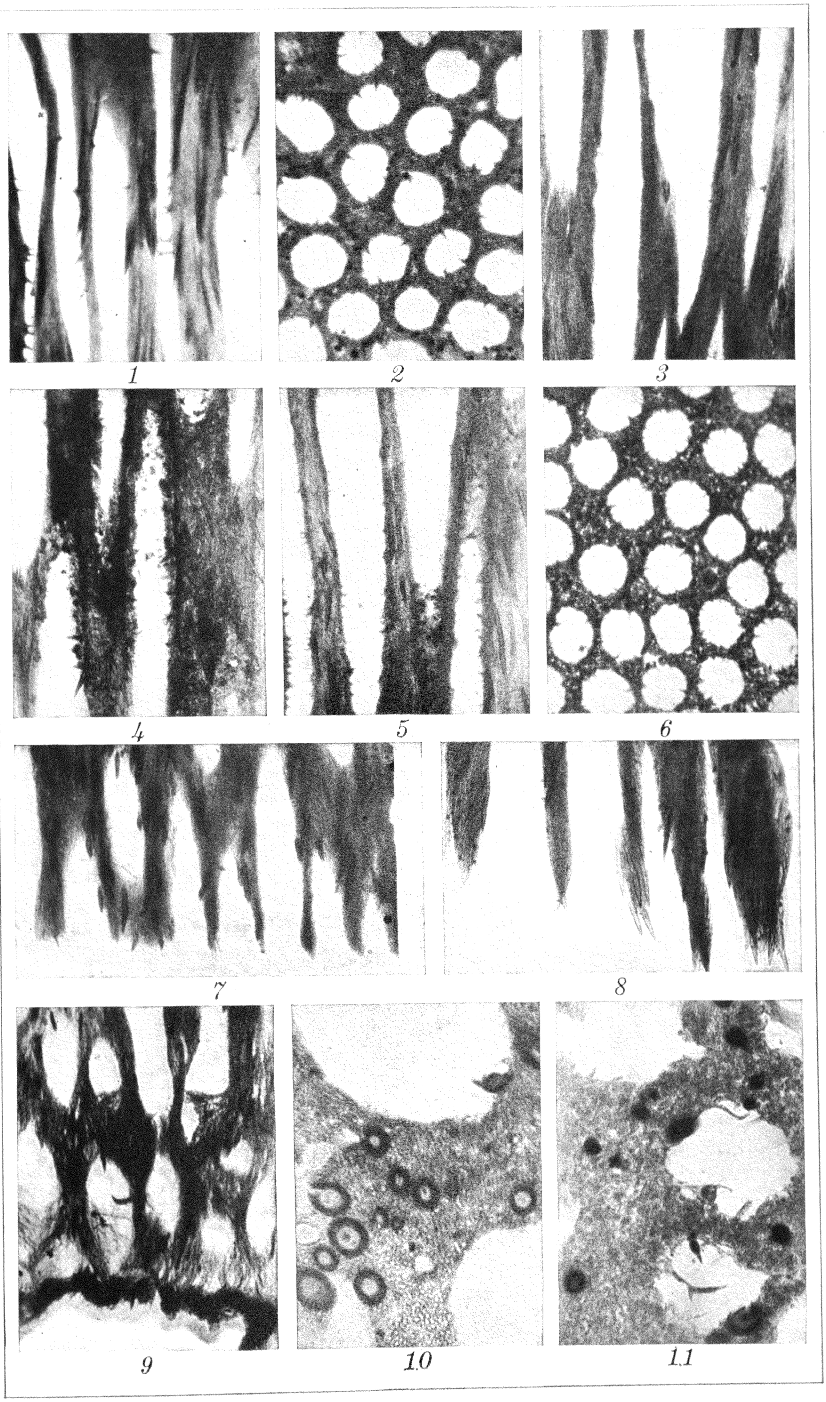

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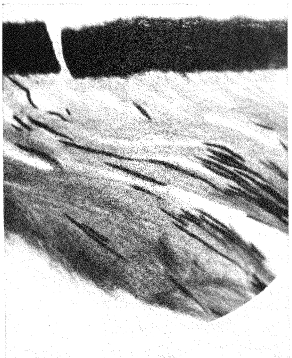

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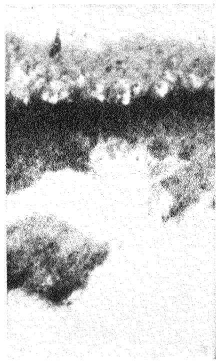

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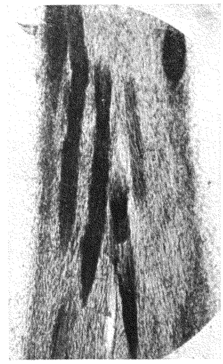

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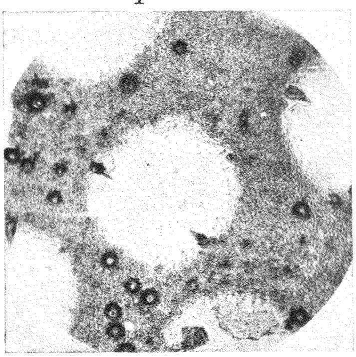

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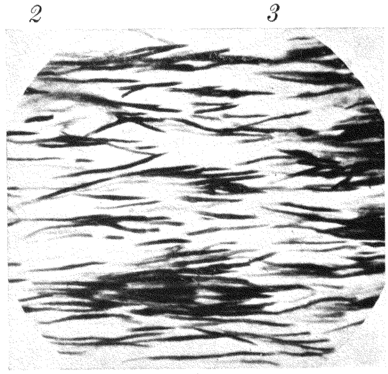

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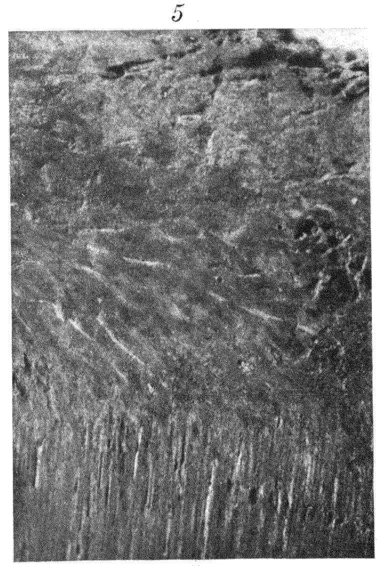

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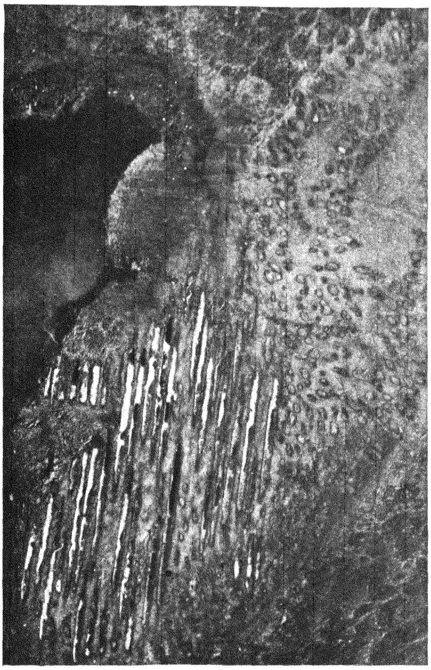

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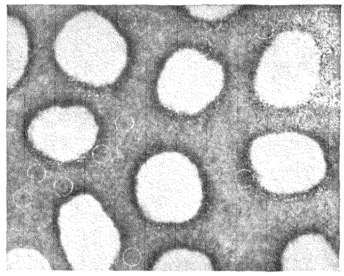

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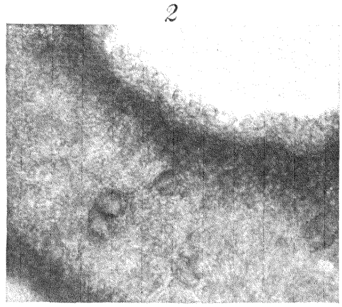

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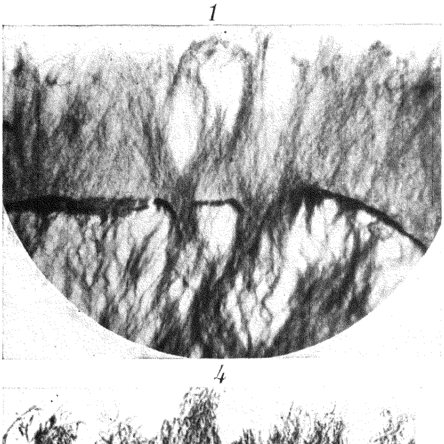

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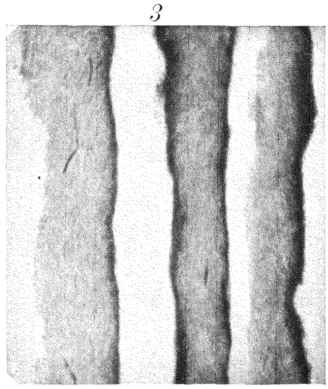

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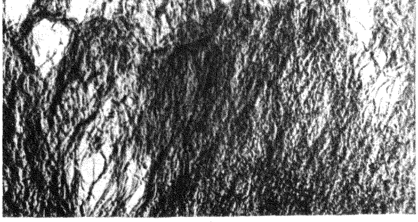

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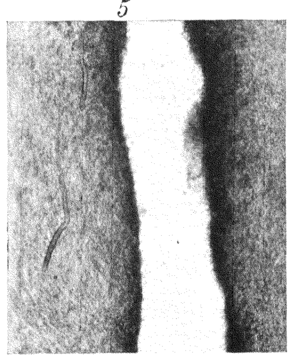

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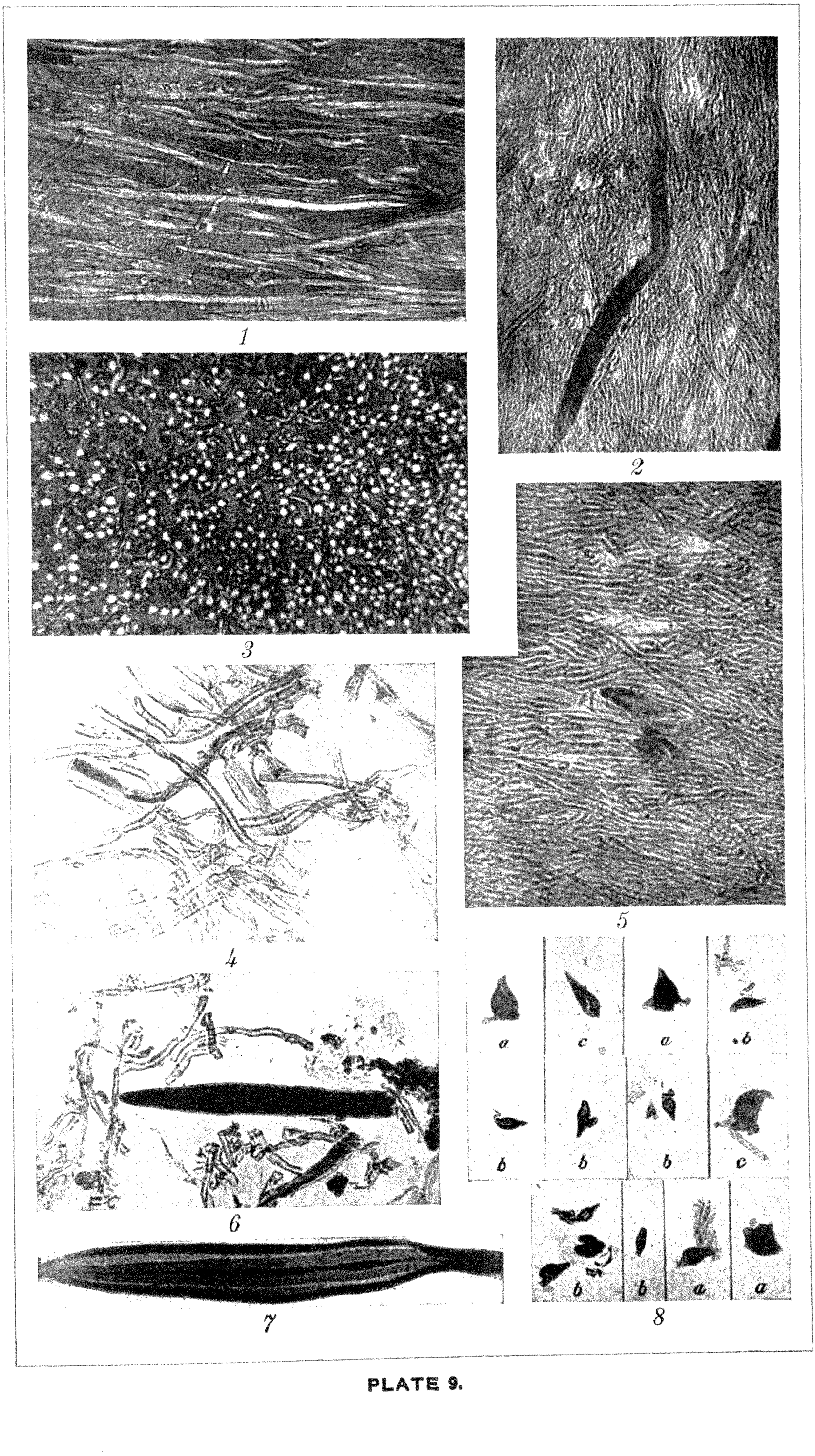

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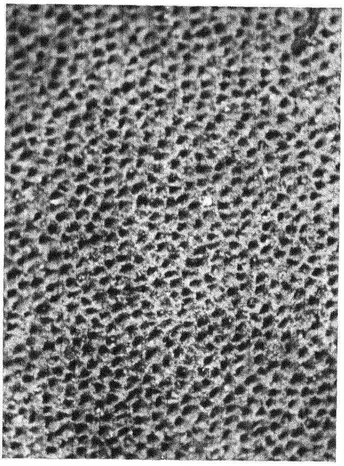

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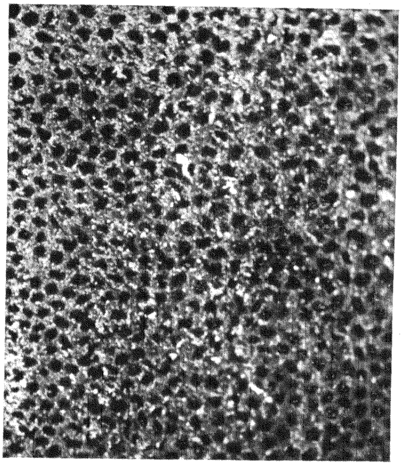

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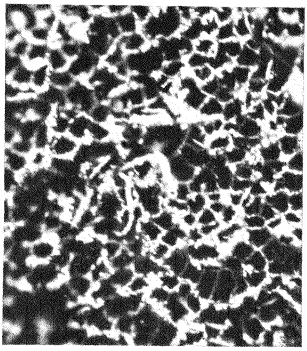

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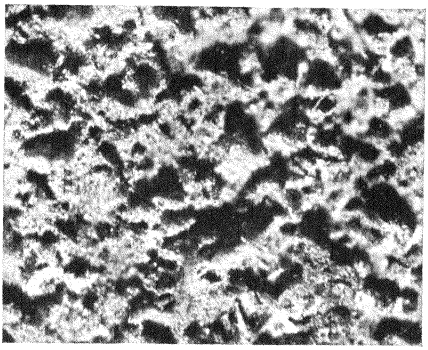

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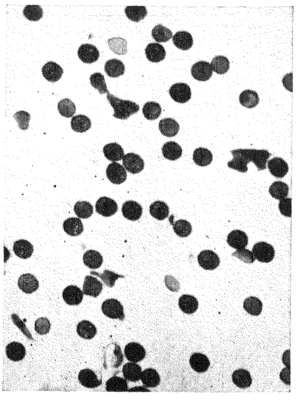

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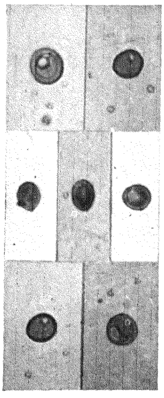

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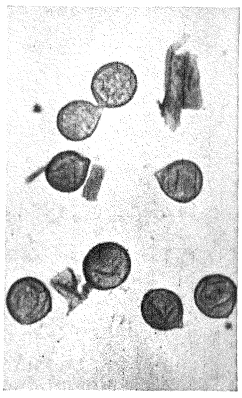

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